JOURNAL OF DAIRY SCIENCE

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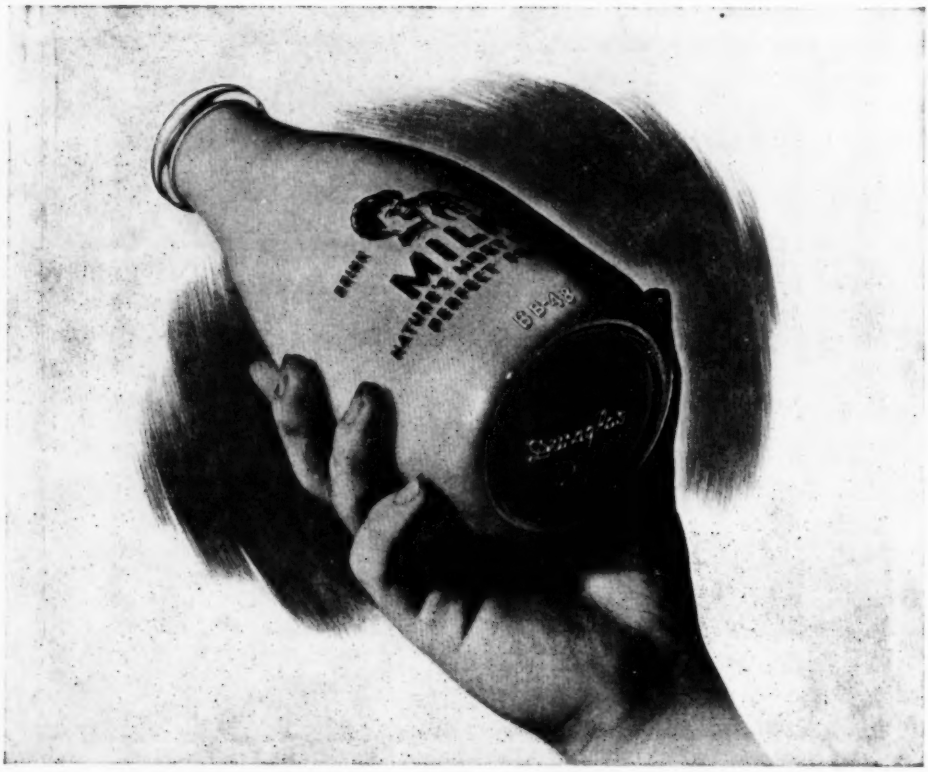

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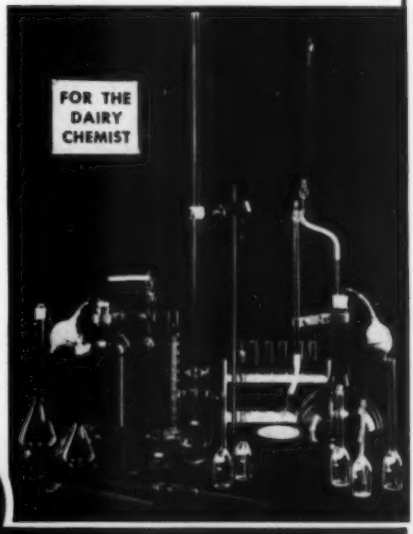

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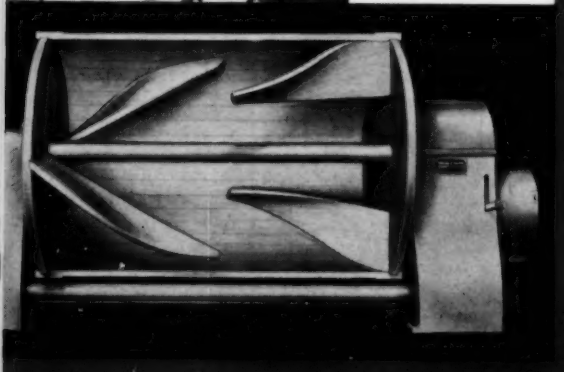

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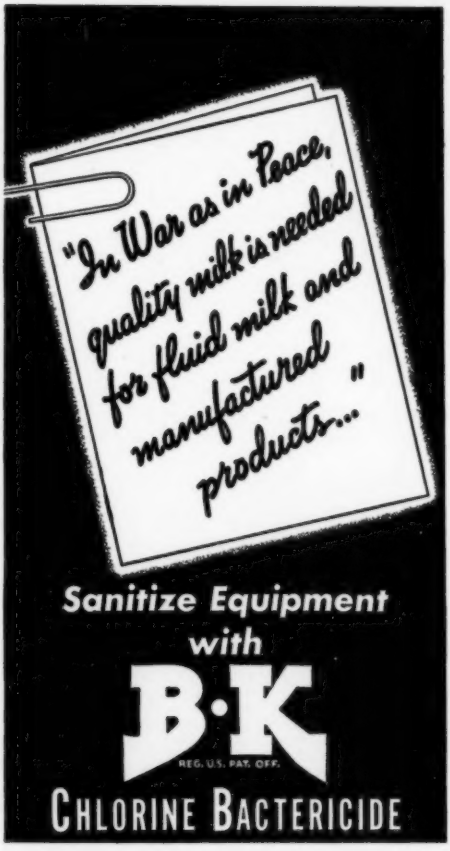
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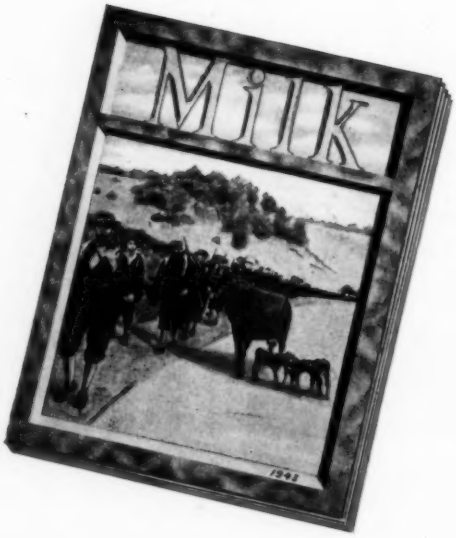

The 1943 issue of "MILK", just recently issued, is packed full of interesting and timely features on modern dairy production. Articles by such recognized men as Professor P. H. Tracy, University of Illinois and Professor C. L. Roadhouse, University of California are contained in its pages. Thoroughly covered and discussed are the subject of Dehydration for milk and eggs, concentrated orange juice, cold wall tanks, vacuum fillers, tubular heat exchangers and others of equal present day importance. The supply of these books is limited —be sure of your free copy by writing for it *today* to:

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JOURNAL OF DAIRY SCIENCE

VOLUME XXVI AUGUST, 1943 NUMBER 8

THE COMPARATIVE VALUE OF UREA AND LINSEED MEAL FOR MILK PRODUCTION*

I. W. RUPEL, G. BOHSTEDT AND E. B. HART

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In earlier work (5), we established the fact that for the growth of calves urea nitrogen could be successfully used for at least a partial supply of the protein nitrogen. This protein supply, from such a simple substance as urea, was made possible through the multiplication of the microorganisms of the rumen. This intervention of microorganisms and the use of urea in no way contradicts the accepted process of protein nutrition through essential amino acids.

Because of the possibility that urea could become a partial source of nitrogen in milk production and be put in competition with the common protein concentrates used in dairy cattle production, such as the oil meals, an experiment with lactating cows was undertaken.

In the spring of 1939, 24 grade Holsteins, fresh from 5 to 13 weeks, were purchased and brought to the University for this study. They were free from disease, as indicated by the usual tests for tuberculosis, Bang's disease, and by several tests (including pH, modified Hotis, catalase, and modified Hayden tests) for mastitis.

They were divided into 4 groups of 6 each. The division was based on the past available milk record, age, and number of previous calvings. Allotments to each group were balanced as nearly as possible from the records available. Three of the groups were to receive in succession and for an entire lactation the 1) basal ration, 2) the basal ration plus urea, and 3) the basal ration plus linseed meal. The order of succeeding rations varied with each group. In other words, each cow was to pass through three lactations involving the basal ration, the same ration plus urea, and the same ration plus linseed meal. The fourth group of 6 cows was to be used to determine the influence of added corn molasses on urea utilization for milk production. In the first lactation they received the urea ration, in the second the urea ration plus molasses, and in the third lactation the urea ration again.

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THE RATIONS

Low protein roughages were chosen purposely. Timothy hay and corn silage were fed to all cows throughout the experiment. The concentrate rations used were as follows:

Basal	lbs.
Ground yellow corn	49.0
Ground oats	49.0
Bone meal	1.0
Iodized salt	1.0

Urea Ration	lbs.
Ground yellow corn	47.5
Ground oats	47.5
Urea	3.0
Bone meal	1.0
Iodized salt	1.0

Linseed Meal Ration	
Ground yellow corn	32.0
Ground oats	32.0
Linseed meal	34.0
Ground limestone	1.0
Iodized salt	1.0

Urea Molasses Ration	
Ground yellow corn	47.5
Ground oats	47.5
Urea	3.0
Bone meal	1.0
Iodized salt	1.0
Corn molasses	10.0

The concentrates of the basal ration contained approximately 10 per cent of total protein. The 3 pounds of added urea (46 per cent nitrogen) raised the protein equivalent ($N \times 6.25$) to 18 per cent in the concentrate portion of that ration. The 34 pounds of linseed meal brought the total protein in that ration to approximately 18 per cent, or the same nitrogen level as in the urea ration. In the linseed meal ration, calcium carbonate (ground limestone) instead of bone meal was used as an extra source of calcium This was done because the phosphorus content of the linseed meal ration was sufficient without further addition. The corn molasses used in the urea-molasses ration contained 75 per cent of sugar and was practically free from nitrogen.

Chemical analyses showed the fat level in the concentrate of the urea ration to be 3.6 per cent and in the linseed meal ration 3.0 per cent. In either case it would appear that these fat levels were sufficiently high to meet the fat requirements for liberal milk production.

One pound of concentrates was allowed for every 3.5 pounds of milk produced. The timothy hay and corn silage fed varied with each individual but usually amounted to from 8 to 10 pounds of timothy hay and 25 to 35 pounds of corn silage daily. Complete feed consumption records were kept. The cows had access to drinking cups, were turned out daily (weather permitting) in a vegetation free paddock, and were machine milked twice daily.

MILK PRODUCTION

The 24 animals used were all fresh when purchased and had milked an average of 48 days by the time the experiment was started. Thirteen were

milking in their first lactation, 6 in their second, 4 in their third, and one in her fourth lactation.

It is well established that the capacity for milk production increases with the age of the cow from first freshening to maturity. It is therefore important to avoid confusing the effect of advancing maturity with the effect of rations fed in succeeding lactations. To avoid such complications the data herein reported are grouped and averaged for the respective rations. Furthermore, cows that failed to complete all three experimental lactations without serious mishap were excluded from the final summary. Thus, any cow included in the average for one ration, is also included in the average for the other rations in the comparison.

TABLE 1

Average milk yield, live weight, and daily feed consumption for same cows on basal, linseed meal, and urea rations

	Basal	Linseed meal	Urea
Number of cows fed	15	15	15
Number of days in period	256	267	268
Weight, lb.:			
Initial	1105	1072	1083
Final	1130	1184	1185
Gain	25	112	102
Daily feed, lb.:			
Concentrates	9.71	10.42	10.22
Silage	34.33	35.18	35.04
Hay	9.20	9.31	9.35
Total 4% F.C.M., lb.	6675	7790	7690
Daily 4% F.C.M., lb.	26.07	29.18	28.69
Total 4% F.C.M. adjusted for age and for estimated portion of first lactation, lb.	7855	9355	8988

Table 1 shows the data on milk production and feed consumption for the 15 cows that completed a lactation on each of the three rations indicated. In the first experimental lactation the record began with the cow already fresh for some weeks, the average period being 48 days. In the succeeding lactations the production record began with the third day after calving. All records were terminated at the 305th day or at such earlier date as was necessary to show a production of not less than 10 pounds of 4 per cent milk per day. The lactation periods handled in this way averaged 256, 267, and 268 days respectively for the basal, linseed meal, and urea rations.

The milk yield after conversion to a 4 per cent fat-corrected basis (2), averaged 6,675 pounds per cow for the basal ration, 7,790 pounds on the linseed meal ration and 7,690 pounds on the urea ration. The respective average daily yields per cow were 26.07, 29.18, and 28.69 pounds.

Various comparisons of the data were made: 1) by cutting out sections of the second and third experimental lactations that matched the first in

stage and length, 2) by estimating the production for first experimental lactations during the period between freshening and the start of the experimental record and adding this to the observed records, and 3) by applying age conversion factors to the respective records to bring them all to a mature basis. None of these treatments of the data changes the essential picture of the comparative results.

When each record is adjusted to mature basis and estimated yields for the period between freshening and the start of the trial are added to the first lactations, the following averages result: basal ration 7,855 pounds, linseed meal ration 9,355 pounds, and the urea ration 8,988 pounds. The records were paired for individual cows and the differences averaged. The average difference between the adjusted records of the same cows on the basal and linseed meal rations was 1499.8 pounds of fat-corrected milk with a standard error of 390.7. The average difference between the records of the basal and the urea rations was 1133.5 pounds with a standard error of 495.7. These figures give 't' values (of 3.839 and 2.287 respectively; after Fisher), in excess of the requirement for significance at the 1 per cent level in the first case, and at the 5 per cent level in the second. ('t' = 2.977 with P = 0.01 and $n = 14$; 't' = 2.145 with P = 0.05 and $n = 14$.)

The differences between the linseed meal and the urea rations averaged 366.3 pounds in favor of linseed meal but the variability was too great to show significance. ('t' = 0.80014 where 2.145 is required for P = 0.05.)

It may be of interest to note that when the adjusted yields are standardized to a basis of 3.4 per cent milk the following averages are obtained: basal ration, 270 day lactation, 8,639 pounds milk; linseed meal ration, 285 day lactation, 10,280 pounds milk; urea ration, 283 day lactation and 9,877 pounds milk. These compare quite favorably with normal expectancy for average cows fed continuously on "winter rations" and receiving corn silage and timothy hay as roughages.

THE INFLUENCE OF MOLASSES IN THE RATION ON MILK PRODUCTION

In some earlier experiments on urea utilization with growing calves we had used corn molasses, which seemed to increase the appetite and accelerate growth. At the time we thought that the use of a soluble sugar might be essential for the production of an active flora and fauna in the rumen. Consequently, 6 of our experimental animals were used for further study of this phase of the urea problem.

The adjusted records were studied by pairing the first lactation record on the urea ration with the second on the molasses-urea ration and by again using the second lactation record and pairing it with the third lactation record on the urea ration. One pair in the latter case was dropped because of a severe mastitis infection in the third lactation. Thus the 6 cows furnished 11 paired records using 5 of the second lactations a second time to pair with the third lactation by the same cows.

The average difference was 356 pounds greater for the urea ration, however 5 of the 11 paired records favored the molasses addition to the urea ration. Statistically, the difference observed was not significant, it being only 43 per cent of the critical difference at the $P = 0.05$ level. Evidently with animals of this age a ration containing grains and their starches will not be improved in respect to urea utilization by the addition of a soluble sugar. It is now evident that the starches of the grains are rapidly broken down to soluble sugars by the microorganism enzymes in the rumen.

MAINTENANCE OF WEIGHT AND APPEARANCE OF THE HERD

Under the plan of feeding, the animals were changed to their next ration 6 weeks before freshening. This was done for the purpose of avoiding any

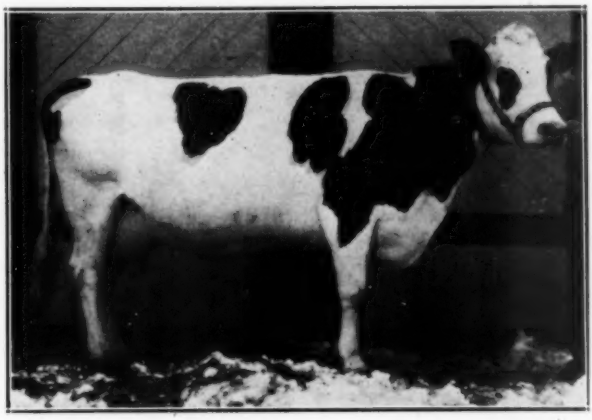

FIG. 1. Cow No. 20—Oil meal ration. Photographed January 1940.

appetite disturbance that might occur had the change been made at the time of parturition. The cows were weighed every 2 weeks. However, to conserve space, no extensive table of live weights during the 3 lactation periods is presented. The average initial and final weights for the 15 lactations on each ration are shown in table 1. It may be seen that the cows averaged very nearly the same initial weight on the respective rations. The average gains shown are 25 pounds for the basal ration, 112 for the linseed meal ration, and 102 pounds for the urea ration. It can be definitely stated that under our system of feeding, where 1 pound of the grain mixture was allowed for 3.5 pounds of milk, energy was not the limiting factor. The limiting factor on the basal ration was protein.

On any of the 3 rations, weight regained after freshening was normal for this class of animals and no disturbances in live weight were observed. For example, on May 17, 1939, No. 9, the heaviest milker in the herd, weighed

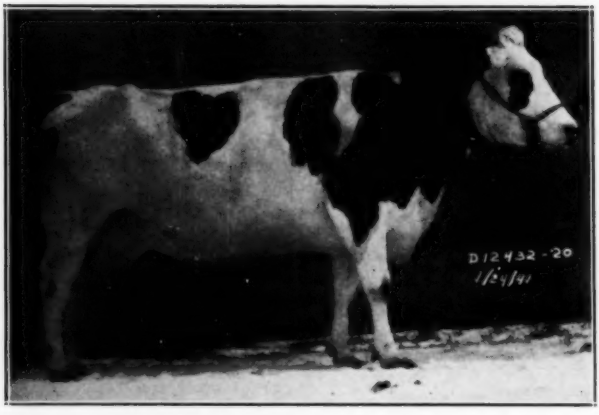

FIG. 2. Cow No. 20—Basal ration. Photographed January 1941.

1,035 pounds 59 days after freshening. Receiving the urea ration, she slowly regained weight and on May 15, 1940, she weighed 1,218 pounds. She freshened August 21, 1940, at a weight of 1,308 pounds. After freshening, her weight dropped to 1,086 pounds. She was then transferred to the linseed meal ration. After the lapse of a year, August 20, 1941, she again weighed 1,248 pounds. In other words, there had been no more rapid regain of weight on the linseed meal ration than on the urea ration. This cow produced in the neighborhood of 12,000 pounds of 4 per cent milk. The live weight history of this animal is typical of the other animals of the herd.

In respect to the appearance of the cows, there was nothing distinguishing in respect to the influence of the ration. (See photographs.) Those on

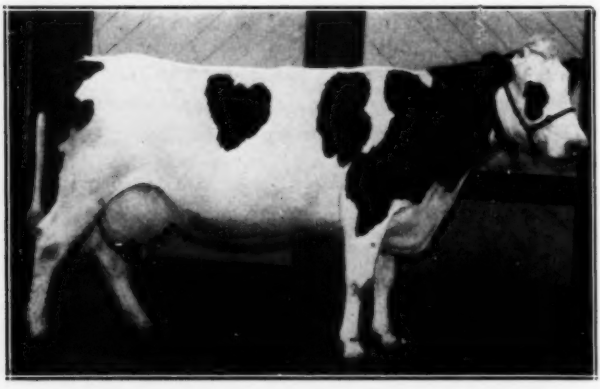

FIG. 3. Cow No. 20—Urea ration. Photographed January 1942.

the linseed meal ration showed no slicker coats nor more bloom than those receiving the urea ration. The live weight records indicate that there was no greater "fullness" on the linseed meal ration as compared with the urea ration. Even on the basal ration the condition of the animals remained excellent. Appearance of hair coat and bloom were good and there was no evidence of sub-nutrition even on the basal ration except in the volume of milk produced.

FEED CONSUMPTION

The cows ate their respective rations readily and periods of "going off feed" occurred no more frequently than would be expected in an average herd of the same size. Such disturbances as did occur, appeared not to be related to the particular ration being fed.

TABLE 2

Feed consumed per 100 pounds 4 per cent fat-corrected milk

Feeds	Basal ration	Linseed meal ration	Urea ration
	lb.	*lb.*	*lb.*
Gr. corn	18.25	11.44	16.91
Gr. oats	18.24	11.43	16.92
Linseed meal	.....	12.14	.....
Urea	.....	.....	1.07
Bone meal	0.37	.....	0.36
Gr. limestone	.....	0.36	.....
Iodized salt	0.37	0.36	0.36
Total	37.23	35.73	35.62
Corn silage	131.7	120.6	122.1
Timothy hay	35.3	31.9	32.6

In table 2 a summary of the feed consumed is presented. These are the actual amounts of feed used during the experimental portion of the respective lactation periods. The amount of feed consumed per 100 pounds of 4 per cent fat-corrected milk is computed directly from the actual feed weights and the actual milk production without adjustment for age or stage of lactation. The concentrates fed per 100 pounds of 4 per cent milk was 37.2 pounds for the basal ration, 35.7 pounds for the linseed meal and 35.6 pounds for the urea ration. Slightly more silage and hay was also consumed on the basal ration than was true with the other two rations. This was natural since a lower level of production was obtained on the basal ration. This meant that a greater proportion of the total nutrient intake was needed for maintenance resulting in a lower ratio of output to intake.

Using the ratio of feed consumed to milk produced, we find that when 8,233 pounds of 4 per cent milk are produced on the linseed meal ration, 1,000 pounds of linseed meal is fed in the concentrates consumed. Along with the linseed meal, 941.2 pounds each of corn and oats were fed (as well as

29.5 pounds of limestone and 29.5 pounds of salt). With the urea ration, to produce a like amount of milk, 88 pounds of urea, 1,393 pounds of corn and 1,393 pounds of oats were used (plus salt and bone meal). From this it may be seen that 88 pounds of urea, 451.7 pounds of corn, and 451.7 pounds of oats were required to replace the 1,000 pounds of linseed meal used in that ration. Furthermore, the cows receiving the urea ration consumed 56.6 pounds more timothy hay and 125 pounds more corn silage.

At $47.00 per ton (current November 1942 prices), 1,000 pounds of linseed meal would cost $23.50. To do the same job with the urea ration, 451.7 pounds of corn and 451.7 pounds of oats costing $13.55 (at $30.00 per ton) were used in excess of the amounts of the same feeds fed with the linseed meal. Also the 56.6 pounds of additional timothy hay at $15.00 per ton, was worth $0.425, and the 125 pounds of extra corn silage, at $5.00 per ton, was worth $0.31. Likewise, the 29.3 pounds of bone meal at $52.00 per ton, cost

TABLE 3

Record of number of inseminations before settling

Cow No.	Urea ration	Linseed meal ration
7	3	1
8	2	1
9	4	5
10	1	2
11	2	1
12	1	6
	13	16

$0.49 more for the urea ration than a similar amount of ground limestone at $18.60 per ton, used in the linseed meal ration.

Adding these values ($13.55 + 0.425 + 0.31 + 0.49 = $14.775), we find that $14.775 worth of feeds in addition to 88 pounds of urea were used to replace the 1,000 pounds of linseed meal, worth $23.50. Thus a difference of $8.72 remains to the credit of the 88 pounds of urea. This is 9.9 cents per pound which is nearly three times its cost when urea sells at $70.00 per ton. When linseed meal sells at a relatively lower price, the advantage of urea would be reduced accordingly.

BREEDING HISTORY

A study of the records shows that there was no disturbing effect of urea feeding on the estrus cycle or the frequency of service to obtain pregnancy. In table 3 is given a brief summary of the records of 6 animals on the urea ration and the same animals on the linseed meal ration in respect to the number of inseminations before settling. These animals were artificially inseminated.

When we remember that the nitrogen nutrition of these animals on urea is after all a nutrition by amino acids derived in part from the reconstructed microbiological proteins of the rumen, there is no reason to expect disturb-

ances from urea feeding provided the amount ingested lies within the zone of safety. This we have already placed at 1 to 2 per cent of the total dry matter of the ration, or not more than 3 per cent of the concentrate mixture. The question of efficiency of urea feeding is one of the biological value of the proteins made by the microorganisms of the rumen and their supplementary effect upon the other proteins that are ingested with the ration.

SIZE OF CALVES

No impairment of reproduction in respect to vigor or weight of calves on the rations used was observed. It was anticipated that our rations might be low in provitamin A and that a partial deficiency of this nutrient would influence reproduction, but no such deficiency symptoms were observed. Approximately 50 per cent of the grain mixture was yellow corn, and the silage and timothy hay carried some carotene. Studies of the blood, reported later, show that the ration supplied sufficient carotene to maintain an ample supply of vitamin A. In table 4 are given the birth weights of

TABLE 4

Weight record of calves

Basal ration			Urea ration			Linseed meal ration		
Cow No.	Lbs.	Sex	Cow No.	Lbs.	Sex	Cow No.	Lbs.	Sex
1	106	M	7	101	M	7	100	M
2	100	F	8	37	F*	8	101	F
3	95	F	9	96	M	9	100	M
4	91	F	10	93	F	10	110	F
5	97	M	11	115	M	11	106	F
6	94	M	12	73	F†	12	79	F
				82	M†			

* Abortion at 211 days.
† Twins.

calves born on the urea and linseed meal rations. No records for the basal ration are available with these same cows because they received the basal ration in the third lactation and some were sold before freshening. However, the record of 6 other cows on the basal ration is given for comparison. The weight of the calves compares favorably with those receiving either urea or linseed meal. No. 8 aborted her calf after carrying the fetus 211 days. The cause of the abortion was unknown, although this herd remained negative to Bang's disease for the duration of the experiment. The record of the calf weights indicates no superiority of one ration over the other for fetus building. Even the basal ration was nutritionally sufficient for the production of normal and vigorous calves.

COMPOSITION OF MILK

The milk produced on the different rations was normal in every respect. On the several rations the protein content of the milk of the cows, as shown by samples taken during the first lactation, was as follows:

Cows 1–6	Average	2.59 per cent	Basal ration
Cows 7–12	"	2.61 " "	Urea ration
Cows 13–18	"	2.64 " "	Urea ration
Cows 19–24	"	2.73 " "	Linseed meal ration

The data do not indicate significant differences. The flavor of the milk of the cows receiving urea has on occasion been questioned. Consequently, the milk of all of the cows was graded by expert milk tasters on June 22, 1939, during the first lactation, and involved the milk produced on the basal, urea, and linseed meal rations. We publish this table in full (Table 5) because it should set at rest any opinion that feeding urea *per se* will give an

TABLE 5

Flavor of milk on basal, urea, and linseed meal rations

Cow No.	Ration	Taster 1	Taster 2	Taster 3
1	basal	O.K.	O.K.	Sl. feedy
2	"	O.K.	Sl. salty	Sl. salty, sl. cowy
3	"	Sl. feedy	Sweet, feedy	Sl. feedy
4	"	O.K.	O.K.	O.K.
5	"	O.K.	O.K.	Sl. flat
6	"	O.K.	O.K.	O.K.
7	urea	O.K.	Full body	Sl. salty
8	"	O.K.	O.K.	Sl. salty
9	"	O.K.	O.K.	O.K.
10	"	O.K.	O.K.	Sl. puckery
11	"	O.K.	Sl. chalky	O.K.
12	"	O.K.	Sl. chalky	O.K.
13	"	Sl. cowy	O.K.	O.K.
14	"	O.K.	O.K.	O.K.
15	"	O.K.	O.K.	O.K.
16	"	Unpleasant	Tart, unclean	Salty, unpleasant
17	"	O.K.	Sl. puckery	Feedy
18	"	O.K.	O.K.	O.K.
19	linseed meal	Cowy	Sl. puckery	Sl. salty
20	"	O.K.	Thin	O.K.
21	"	Sl. feedy	O.K.	Sl. feedy
22	"	Cowy	Sl. feedy, flat	O.K.
23	"	O.K.	O.K.	Chalky, not pleasing
24	"	O.K.	Sl. flat, chalky	Sl. salty

off flavor to the milk. It will be observed that expert tasters varied in their ratings. On the basal ration (6 cows), one taster reported 80 per cent OK and another 30 per cent OK. On the urea ration (12 cows), taster 1 reported 83 per cent OK, and the other two, 60 per cent. On the linseed meal ration (6 cows), taster 1 reported 50 per cent OK and the other two tasters, 30 per cent OK. If one wishes to rely on the above tests as sufficient evidence in respect to milk flavor, then the urea fed cows were producing a better flavored milk than the linseed meal fed cows—but no such interpretation is made by the authors.

UREA IN MILK

It might be assumed that feeding urea would increase the urea content of milk. A glimpse at table 7 will indicate that the level of urea in the blood is, within limits, related to the protein level in the feed. This table will also show that urea feeding had not increased the urea level in the blood. Consequently no urea increase in the milk would be expected from the cows fed urea. Analysis of the milk showed this to be the case. The literature records the urea level in the milk as varying from 0.01 to 0.03 per cent. Our analysis of the milk from the cows fed urea ranged from 0.011 per cent to 0.015.

VITAMIN C CONTENT OF THE MILK

There was considerable individual variation in the vitamin C content of the milks. In Lot 1 (basal ration), it ranged from 16.7 to 26.3 mg. per liter with an average of 20.5 mg. for the 6 cows. On the urea ration, Group 2 (6 cows), the range was from 17.4 to 28.6 mg. with an average of 23.1 mg. On linseed meal the range was from 21.2 to 30.3 mg., and an average of 23.5 mg. While we do not wish to stress the point, yet on the basal ration (low protein) the amount of vitamin C in the milk averaged definitely lower, by 3 mg. per liter, than on the urea and linseed meal rations. These analyses were again repeated after an interval of several months, and again the same type of results were obtained—basal ration (6 cows) 18.1 mg. of vitamin C per liter; urea ration (6 cows) 23.0; urea ration (6 cows) 21.3; linseed meal ration (6 cows) 21.7.

It would be of interest to study further the influence of the protein level on the vitamin C synthesis in this species.

OTHER VITAMINS IN THE MILK

During the course of this experiment we determined the riboflavin, pantothenic acid, vitamin A, and carotene content of the milk. The first two are expressed as micrograms per cc. and the last two as micrograms per gram of butterfat. The samples for the assay of flavin and pantothenic acid were homogenized, frozen, and melted as assayed. Composite samples of each group for the assay of vitamin A and carotene were collected and analyzed the next day without freezing.

The averages from the milk of several cows in each group are recorded in table 6. The results are much alike for the three rations. The vitamin A and carotene content of the butterfat was what would be expected on a ration such as used where no fresh green material was allowed. Of interest was the constancy of the concentration of any of these nutrients independent of volume of milk secreted. A cow giving 50 pounds of milk per day had as high a percentage concentration of any of these nutrients as one giving 5 pounds of milk daily.

TABLE 6

Vitamins in the milk

Ration	Pantothenic acid	Flavin	Vitamin A	Carotene	Per cent butterfat
	γ *per cc.*	γ *per cc.*	γ*/gm. B.F.*	γ*/gm. B.F.*	
Basal	4.00	2.53	7.25	4.40	3.7
Urea	4.28	2.33	6.70	5.25	4.1
Linseed meal	4.38	2.34	7.07	5.15	3.4

COMPOSITION OF THE BLOOD (NITROGEN DISTRIBUTION)

During the progress of this experiment, the blood of the cows was analyzed for urea, non-protein nitrogen, serum protein, and total blood protein. These determinations were made after the cows had been on the experiment in the first lactation for approximately 3 months. They are given in table 7. It is apparent that on the basal ration, where a lower protein intake prevailed, the urea and non-protein nitrogen content of the blood were lower than on the other rations. This would be expected. In all groups the serum protein and total blood protein were well maintained and closely comparable.

TABLE 7

Analysis of cows' blood

Lot	Cow No.	Mg. urea N/100 cc.		Mg. NPN/100 cc.		Per cent serum protein	Per cent total blood protein
I Basal	1	14.5	12.5	29.7	27.4	7.52	15.97
	2		15.5		29.8	7.22	17.30
	3		13.0		29.6	7.60	17.18
	4		12.2		25.5	7.58	15.67
	5		15.5		30.0	7.78	15.56
	6		18.5		35.8	6.74	15.58
II Urea	7	16.9	15.7	35.4	34.0	7.67	15.95
	8		16.2		34.2	7.32	17.15
	9		19.6		37.7	7.48	15.85
	10		16.8		38.6	7.40	15.85
	11		16.1		36.6	7.72	16.31
	12		16.8		33.2	7.98	15.70
III Urea	13	18.8	18.5	39.4	39.3	7.78	15.61
	14		16.8		34.5	7.07	16.10
	15		18.2		42.2	7.43	17.85
	16		18.5		37.0	7.29	17.74
	17		23.4		46.2	7.34	15.70
	18		17.6		37.4	6.89	16.20
IV Linseed meal	19	19.3	19.3	38.5	37.5	7.78	15.50
	20		19.4		39.5	7.39	16.15
	21		21.0		40.2	7.41	16.25
	22		19.6		37.4	6.89	15.60
	23		18.3		36.6	7.35	15.41
	24		18.5		39.8	7.73	16.9

VITAMIN C, A, AND CAROTENE CONTENT OF THE BLOOD

Since studies at this station by Phillips and associates have disclosed the importance of the levels of vitamins A and C in the blood for normal physiology of this species, it was considered of sufficient importance to make these determinations in view of the fact that this herd had been on these rations without access to fresh green material for at least 3 years. The only succulence they had was the corn silage. These determinations were made in February 1942. Not all the animals were involved—but a sufficient number on each ration to give an over-all picture of the situation. The records are given in table 8. The vitamin C ranged from 0.29 to 0.49 mg. per 100 cc. of blood. This is considered within the range of normal values. However, it should be recorded that several of these cows with delayed pregnancies were

TABLE 8

Analyses of blood samples for vitamins A, C and carotene, taken February 20, 1942

Cow No.	Ration	Vitamin C	Vitamin A	Carotene
		mg./%	*γ/100 cc.*	*γ/100 cc.*
1	Linseed meal	0.40	23	433
5	"	0.33	13	331
8	Basal	0.46	14	296
11	"	0.37	29	324
12	"	0.44	21	425
13	Urea	0.41	23	390
14	"	0.40	18	333
19	"	0.29	17	264
20	"	0.49	25	367
23	"	0.40	16	350

effectively settled with calves by the injection of vitamin C. One notable case was cow 17. She failed to conceive on 8 successive estrus periods. Just prior to the occurrence of the 9th estrus cycle, she was injected with vitamin C and artificially inseminated. A successful pregnancy followed. The blood vitamin A level varied from 13 to 29 gammas per 100 cc., which is within the range of adequate levels, at least for yearling calves. The carotene content of the blood was also ample.

MICROORGANISMS OF THE RUMEN OF THE COW

The development of this subject is in its infancy. Only preliminary observations have been made and fuller reports will follow later from the Department of Agricultural Bacteriology of this station. The rumen of the adult bovine has a capacity of 25 to 60 gallons. It is here that large quantities of ingested food are added to water and saliva and mixed until the cow is able to regurgitate the feed and chew it thoroughly. The amount of saliva secreted daily has been estimated at 100 pounds. This secretion has a pH of about 8.4 and helps maintain the reaction of the rumen content between 6.5 and 7.2. The temperature is about 38° C. and reaction and

temperature are ideal for a host of microorganisms provided the proper substrate for multiplication is available.

From other studies with a heifer having a rumen fistula, it has been shown that some fermentable carbohydrate (starch is the only carbohydrate studied so far) must be present for the development of a suitable flora for urea utilization. Some protein may also be necessary. But, as already shown, if the level of protein in the grain mixture exceeds 18 per cent, then the utilization of urea is decreased. It is apparent that our basal ration containing the grain starches and a low level of protein furnished a rumen medium in which microorganisms could thrive and multiply. Observations have shown that in the active flora there are bacteria, molds, yeasts, actinomyces, and protozoa—all of which inhabit the paunch of ruminants receiving hay in the ration. The microorganisms are active digesters, both proteolytically and amylolytically.

In an ordinary wet mount preparation of rumen material, the most noticeable organisms are the protozoa. Their number usually amounts to one million per cc. of the liquid material of the rumen and they do not vary a great deal in number during the digestion periods between feeding. Besides the protozoa there are many kinds of bacteria as well as yeast cells. The latter are much more numerous 1 to 3 hours after feeding than they are later in the digestion period, due probably to their rapid action in attacking the readily digestible sugars in the ration. Practically all morphological types of bacteria are recognizable. The forms ordinarily visible are large diplococci, various streptococci, short rods, single cocci, and a few spore-forming rods, an occasional fibrionic form, and usually a spirochaete. The number of bacteria per cc. of rumen fluid as determined by the Breed count method ranged from one to four billion.

This short discussion makes it apparent that there is an extremely large and varied microbial flora and fauna in the rumen capable of attacking many substances under practically complete anaerobic conditions and producing a variety of products of gaseous and other natures. The question raised is: are these products available to the animal by direct absorption, or must everything first be metabolized by microorganisms?

ECONOMY OF UREA FEEDING

The question of economy of urea feeding as compared with protein concentrates is a complex one. Among other factors it involves the prices of urea, the grains composing the concentrate mixture, and the oil meals used in building the ration. The highest grade of urea contains 46 per cent of nitrogen, while some other grades contain 42 per cent of nitrogen. On the basis of $70 per ton for the 42 per cent grade, a pound of nitrogen in urea would cost 8⅓ cents. A ton of linseed meal containing 35 per cent of protein costs at the present writing (November 1942), $47.00 per ton. A pound of linseed meal nitrogen costs 42 cents, or five times the cost of urea nitrogen.

Such a calculation, however, does not take into account the energy and additional nutrient values contributed by the linseed meal. Urea contributes no energy, only nitrogen. In our grain ration, 3 pounds of urea plus 31 pounds of corn and oats were used to replace 34 pounds of linseed meal. (Actually, the urea used contained 46 per cent nitrogen and was mixed at the rate of 3 pounds in 100 pounds of the concentrate mixture.) It appears that a grade of urea containing 42 per cent of nitrogen can be placed on the market at a more favorable price per unit nitrogen. Therefore, these computations are based on the use of the 42 per cent grade with 3.3 pounds in each 100 pounds of the concentrate mixture. The following tabulation indicates the saving that may be made when urea is used to replace linseed meal:

At $70 per ton, 3.3 pounds of urea cost	$0.1155
At $30 per ton, 31 pounds of corn and oats cost	0.465
Total	$0.5805

Cost of Linseed Meal:	Saving in Cost of Feed Mixture, per 100 lbs.	Ton
	$	$
34 pounds linseed meal at $34.15 = $0.58	None	None
34 pounds linseed meal at $40.00 = $0.68	0.10	2.00
34 pounds linseed meal at $47.00 = $0.80	0.22	or 4.40

It is apparent that, at the prices allowed for corn, oats, linseed meal, and urea, when the linseed meal runs over $34.15 per ton, urea feeding may be economical provided a 42 per cent urea can be purchased at $70 per ton. In table 9, values are shown for urea at varying price levels for other feeds.

TABLE 9

Value of urea per ton (42% N grade)

Computed on the basis of feeds consumed per 100 pounds 4% F.C. milk produced on the experimental rations.

It should be economical to use urea as a source of nitrogen in the ration whenever it is priced lower than the values indicated in this table.

Full value from urea may be obtained only when the total protein equivalent intake (based on total N) is not in excess of feeding standard requirements.

When one ton of corn and oats (ground) are worth:	When one ton of linseed meal is valued at:					
	$25	$30	$35	$40	$45	$50
$40	−$141	−$ 89	−$ 37	$ 15	$ 67	$118
35	− 94	− 42	10	62	113	165
30	− 47	5	57	108	160	212
25	0	52	103	155	207	259
20	47	98	150	202	254	306

In computing the above values, fixed prices per ton for the other feeds involved were used as follows: timothy hay $15.00, corn silage $5.00, bone meal $52.00, ground limestone $18.60, and salt $32.00.

When timothy hay is decreased to $10.00 and corn silage to $4.00 per ton, with other prices fixed, the allowance credited to urea is increased by $4.23 per ton; when the roughage values are increased to $20.00 and $6.00 respectively, the urea values decrease by $4.23 per ton. This is due to the fact that somewhat more silage and hay was consumed for each 100 pounds milk produced on the urea ration.

DISCUSSION

It appears that every investigator who in recent years has worked with urea as a partial source of nitrogen for maintenance, growth, or milk production in polygastric animals, has concluded that urea nitrogen can be utilized. Harris and Mitchell (3), working with sheep, found a maintenance in body and nitrogen equilibrium for well over a hundred days on rations containing urea and minimal amounts of protein. The same authors (4) found again with lambs that the addition of urea to a low nitrogen ration, that in itself was unable to support appreciable growth or consistently maintain nitrogen equilibrium, converted the ration into one promoting a normal or nearly normal rate of growth. They gave urea nitrogen a biological value of 74 in a ration where the urea nitrogen constituted about 50 per cent of the total nitrogen. In their work with growing calves (5), Hart, Bohstedt, Deobald, and Wegner secured similar data. Bartlett and Cotton (1), in their work with growing young cattle found that adding urea to a ration supplying a limited amount of protein increased the daily rate of growth by 0.24 pounds. Similar results have been secured by Work and Henke (6) with dairy heifers. They used a ration of corn molasses, pineapple pulp, crude oats, rolled barley, tuna fish, soybean oil meal, salt, and bone meal. In the urea ration, urea displaced the protein concentrate made of tuna fish and soybean oil meal. The urea fed animals averaged 1.15 pounds of live weight gain per day while those on the control ration gained 1.4 pounds daily over a period of 52 weeks. In our own experiments with the same class of animals we obtained a gain of 1.5 pounds daily on a ration where casein constituted 43 per cent of the total nitrogen and 1.3 pounds daily for a comparable level of urea nitrogen.

The evidence from the experimental records in the literature support the general thesis that urea can function as a partial source of nitrogen for maintenance and growth in cattle and sheep.

It should be pointed out that in the case of sheep, investigators have not always been in agreement as to the efficiency of urea as a partial source of nitrogen. It is conceivable that this class of animals, with the generous need for sulfur-containing amino acids for wool production, may not be able to meet this demand for microbiological proteins. So far as there is any direct evidence, the proteins of bacteria and molds are low in sulfur-containing amino acids, particularly cystine. If this is generally true for microorganisms including the protozoa, and both cystine and methionine are low, then the addition of sulfur or sulfates to a urea ration would be of no avail. It would be necessary to provide, preformed in the ration, proteins fairly rich in sulfur-containing amino acids. This phase of the problem in reference to sheep, needs study.

Our own data in respect to milk production, weight of calves, reproduction history, and composition and flavor of the milk produced would lead

to but one conclusion, namely, that urea in our ration at a level of 1 per cent of the dry matter of the entire ration, or 3 per cent of the concentrate mixture would substitute effectively for the oil meal used in the control ration. The urea nitrogen constituted about 46 per cent of the nitrogen of the concentrate mixture and 27 per cent of nitrogen in the entire ration.

SUMMARY

1. Twenty-four Holstein cows were involved in a study of the possibility of substituting urea nitrogen for linseed oil meal nitrogen in milk production. Fifteen of the cows completed a lactation on each of the basal, urea, and the linseed meal rations. Six of the cows were involved in a study of the effect of corn molasses on urea utilization. Each completed a lactation on a urea, a urea-molasses, and a urea ration.

2. On the basal ration the protein level in the concentrate mixture was about 10 per cent. With the added urea or linseed meal it was 18 per cent protein equivalent. Timothy hay and corn silage constituted the roughage.

3. In milk production some cows led on the linseed meal ration while others led on urea with average differences favoring linseed meal in too small a degree to be statistically significant. On the basal ration, with its lower protein content, less milk was generally produced than on either of the other two rations and the cows failed to keep up their live weight as well as on either the linseed meal or urea rations. It appears that with this species and a suitable ration in respect to carbohydrate content, urea can function as a source of nitrogen as effectively as can oil meal.

4. In respect to weight of calves and breeding history, one ration appeared as efficient as the other.

5. The composition of the milk, the flavor of the milk, and the composition of the blood were not different on the two rations.

6. There was no sustained and positive evidence that molasses feeding on a grain ration improved the utilization of urea. With the starches of the grains available, sugar is rapidly produced in the rumen and serves as a suitable substrate for the organisms.

7. Urea (46 per cent nitrogen) should not be fed at a rate greater than about 1 per cent of the dry matter of the ration or 3 per cent of the concentrate mixture. In dairy sections where hay, silage, and home grown grains are available, a suitable nitrogen level in the concentrate mixture can be secured by the addition of 3 pounds of urea to 97 pounds of the grain mixture.

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COMPOSITE VS. FRESH SAMPLES OF MILK FOR DETERMINING PERCENTAGE BUTTERFAT OF COWS ON HERD TEST*

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Breeders of dairy cattle recognize the importance of testing their herds for production, yet less than five per cent of the dairy cows in the United States are being tested. The several Breed Associations are no less anxious to have a large percentage of the cows in their respective breeds on official test. Continuous testing for production is accepted as an essential to progress of the breed and for the best interest of the breeder. Therefore every effort should be made to have as many cows as possible on test continuously.

To encourage dairy cattle breeders to maintain their herds on test continuously the cost should be at a minimum consistent with accuracy. Taking individual samples of milk from each cow over one- or two-day periods and testing these samples in duplicate, obviously requires considerable time. This time is justifiable if this were the only method by which one could get an accurate test on a cow. This brief article points out two methods of testing cows for production, which vary widely in cost.

COMPOSITE SAMPLES

The compositing of milk samples for butterfat testing has been practiced in cheese factories and market milk plants for some time. Some creameries receiving sweet cream also practice making composite samples of cream from the individual producers and test every week or every fifteen days.

The accuracy of the test of composite milk samples preserved with mercuric chloride, compared with the butterfat test of fresh milk samples has been investigated by several station workers.

Sanmann and Overmann (6) concluded from carefully controlled experiments that when composite samples were preserved with mercuric chloride and held at 44–50° F. the composite sample tests were 0.0125 per cent lower than the average test of daily fresh milk samples.

England and DeAmbrough (2) concluded after several experimental trials that the average tests of composite samples were slightly lower than the average tests of fresh milk samples, no matter what the length of the holding period (7 to 15 days) was; the temperature (45 to 100° F.) at which held; or the amount of preservative ($\frac{1}{2}$ to 2 tablets $HgCl_2$) used.

Fahl and Lucas (3) found that the daily average tests of fresh milk samples were slightly higher than the tests of bi-monthly composite samples. When the composite milk samples were kept at the proper temperature

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they concluded that daily testing of fresh-milk samples were approximately fifteen times as costly as 15-day composite samples.

Wilster and Robichaux (8) after conducting a number of experimental trials concluded that:

1. When composite samples of milk were tested by the Babcock method the results showed small decreases in the fat percentages as compared with the average fat percentages obtained from daily testing.

2. A statistical analysis of the results failed to show that decreases obtained with the composite method of testing had much significance, however the number of composite samples were generally lower than with the daily method of testing.

3. The difference in daily and composite tests were:

60– 5	day	composite	samples	0.016	per	cent
420– 7	"	"	"	0.021	"	"
900–15	"	"	"	0.027	"	"

Meade, DeVoe, and Leckie (5) found that fresh milk samples had an average test of 0.09 per cent higher than the average of composite samples of the same milk. Their work showed that there was less variation in composite samples than in fresh milk samples. The fresh milk samples had a range 20 per cent greater than the composite milk samples.

Campbell, Jaggard and Morris (1) found in two series of tests that composite sample tests were lower than fresh sample tests. The average decrease ranged from 0.03 to 0.01 per cent.

Jackson (4) reviewed the literature on preservatives best suited to preserving composite milk samples. He concluded that mercuric chloride ($HgCl_2$) was the best preservative. From his experimental work he concluded that 0.05 grams of mercuric chloride would keep 150-cc. samples of milk for at least 15 days, but that an excessive amount of mercuric chloride was not responsible for abnormal tests.

Tracy and Tuckey (7) in checking on the method of sampling fresh milk at 400 plants in the Champaign Milk Producers Association, and their method of compositing milk for weekly testing, concluded that composite milk tests indicate the true test of milk; that it was not necessary in making composite samples to take aliquot portions of the fresh milk composited. They concluded further that periodic sampling and testing of milk would not be satisfactory where the variations in daily tests are wide.

In appraising the results secured by all the Experiment Station workers on this problem, it should be borne in mind that their testing was conducted under carefully controlled experimental conditions. Therefore small differences could be detected. In Herd or Advanced Registry Testing which is conducted under practical barn conditions the opportunities for sampling and testing can not be done so carefully. Therefore the minute differences

reported by Station workers would not be detected under Herd Testing conditions.

EXPERIMENTAL TRIALS

The South Dakota College dairy herd has been on the Herd Registry Test since 1932. During this time a one day official test was made on fresh milk samples by a supervisor. Samples were taken and tested in the manner prescribed by the official testing rules for this period.

The milk from each cow has been weighed since the herd was established regardless of the plan of testing. A three-day composite milk sample was also taken each month during the Herd Testing period for our private records, by the regular milkers. These samples were taken with a milk sampling dipper, and did not constitute an aliquot portion. The composite sample of milk, consisting of about 100 cc. of milk from each cow, was preserved with ½ tablet of mercuric chloride.

TABLE 1

Average percentage butterfat for year of composite milk samples

Year	Jerseys		Guernseys		Holsteins		Brown Swiss	
	Cows	Butterfat	Cows	Butterfat	Cows	Butterfat	Cows	Butterfat
	No.	%	*No.*	%	*No.*	%	*No.*	%
1933	10	5.58	12	5.02	20	3.75	.....	.....
1934	13	5.50	14	5.20	18	3.68	.....	.....
1935	14	5.44	11	5.16	20	3.67	.....	.....
1936	15	5.49	13	5.11	28	3.79	.....	.....
1937	20	5.38	14	4.96	31	3.46	4	4.02
1938	17	5.64	12	5.05	32	3.45	6	3.94
1939	13	5.62	15	4.98	30	3.22	8	3.83
1940	12	5.49	14	5.08	25	3.40	12	4.02
Av.—8 yrs.		5.52	.....	5.07	.....	3.55	.....	3.95

The composite samples usually were tested two or three days after they were completed. They were not tested in duplicate, whereas the fresh milk samples were. The fresh milk samples in most instances were tested within a few hours after they were taken. The time for conducting the tests on composite samples varied because the testing was done by students and the work was fitted to their free periods.

The private herd records were computed from actual weights of milk from each cow. Whereas the Herd Registry Test was based on one day's milk production and the test of the fresh milk samples for each milking for one day.

The data in table 1 show the number of cows and the composite test for the year. This test represents the average of all cows for the year. In some cases the cow may have been tested only two or three months in that year yet her test was averaged with all the tests.

Table 2 shows the average test of the same cows as indicated by the official method of sampling and testing milk. These tests represent the average of the two milkings of the fresh milk samples from each cow.

Inasmuch as 443 cows of the four breeds were milked over a period of eight years, the results of the two methods of testing are significant. The average test over the eight-year period is slightly in favor of the fresh milk samples. However, the difference is so slight that when the cost of testing a herd by the two sampling methods is considered, the minute difference can be ignored.

In reviewing the monthly tests of the various cows by the two methods, the composite test seemed to vary less from month to month than the fresh milk tests. This can readily be explained because of the possible abnormal

TABLE 2

Average percentage butterfat for year of fresh milk samples

Year	Jerseys		Guernseys		Holsteins		Brown Swiss	
	Cows	Butterfat	Cows	Butterfat	Cows	Butterfat	Cows	Butterfat
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1933	10	5.52	12	5.15	20	3.71	.....	.....
1934	13	5.58	14	5.25	18	3.81	.....	.....
1935	14	5.44	11	5.21	20	3.73	.....	.....
1936	15	5.49	13	5.13	28	3.65	.....	.....
1937	20	5.40	14	5.08	31	3.47	4	4.25
1938	17	5.71	12	5.12	32	3.47	6	3.91
1939	13	5.69	15	5.00	30	3.16	8	3.94
1940	12	5.49	14	5.07	25	3.40	12	3.94
Av.—8 yrs.		5.54	.....	5.13	.....	3.55	.....	4.01

conditions of cows on the day the fresh milk tests were taken such as being in heat, an abnormally hot or cold day, and many other factors that would affect the amount of milk and test for the one day. A three-day or better yet, five-day, composite sample would tend to level off such abnormal tests.

Cost of testing. The cost of testing in a large herd by the two methods, is the important difference. In taking fresh milk samples from a herd of fifty milking cows on three times a day milking and testing each sample in duplicate, the supervisor would have 300 samples to test for the one day, whereas if composite samples were made for the one day he would have 50 tests to make.

The data in table 1 are based on a 3-day composite. It is not known that a one-day composite sample would give equally satisfactory results over a long period of time because abnormal factors affecting the test tend to be levelled off over a longer period of sampling. However the difference between even a one-day composite and the testing of fresh milk samples justifies the former method of sampling for Herd Testing.

TABLE 3

Average pounds milk and butterfat for year by breeds computed by composite test and actual weight of milk

Year	Jerseys			Guernseys			Holsteins			Brown Swiss		
	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat
		lbs.	*lbs.*		*lbs.*	*lbs.*		*lbs.*	*lbs.*		*lbs.*	*lbs.*
1933	8.33	5799.9	308.3	8.33	4800.0	245.3	16.66	8984.8	318.3	.....	.....	.....
1934	9.37	5164.0	275.1	8.08	5056.3	251.8	16.90	8283.0	302.7	.....	.....	.....
1935	11.80	5332.2	282.4	8.66	5744.0	288.0	17.85	9648.0	351.2	.....	.....	.....
1936	14.21	5499.4	291.4	10.60	5898.5	299.9	22.96	10288.4	364.7	.....	.....	.....
1937	15.02	5169.0	271.0	11.10	5401.1	262.6	24.25	9874.0	334.3	.66	8955.0	361.0
1938	12.44	5617.0	298.0	7.85	5754.0	264.2	19.84	10129.1	333.2	5.33	8567.0	330.2
1939	11.25	5554.0	305.3	11.60	5991.0	289.9	20.83	11320.0	365.9	5.68	8205.0	331.7
1940	9.54	6336.0	343.2	10.81	6016.0	300.1	17.58	12497.0	413.2	9.56	9041.7	356.1
Average		5558.94	296.88	.....	5537.5	271.69	.....	10128.04	347.94	.....	8604.6	339.33

TABLE 4

Average pounds of milk and butterfat for year computed on one-day official test

Year	Jerseys			Guernseys			Holsteins			Brown Swiss		
	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat	Cow year	Milk	Butterfat
		lbs.	*lbs.*		*lbs.*	*lbs.*		*lbs.*	*lbs.*		*lbs.*	*lbs.*
1933	8.44	5830.0	312.55	.....	.....	.....	11.30	9557.0	378.68	.....	.....	.....
1934	9.47	5377.0	278.84	.....	.....	.....	13.29	9776.5	368.29	.....	.....	.....
1935	11.13	5690.0	299.12	.....	.....	.....	16.04	10832.1	397.97	.....	.....	.....
1936	14.23	5547.0	297.86	.....	.....	.....	18.73	11738.2	417.48	.....	.....	.....
1937	15.81	4833.0	257.37	.....	.....	.....	19.89	11267.3	384.28	.....	.....	.....
1938	12.53	5656.0	306.09	.....	.....	.....	15.83	11063.5	371.78	4.24	10032.6	388.88
1939	11.24	5702.0	318.51	.....	.....	.....	15.00	11826.0	362.50	5.67	9555.2	380.10
1940	9.96	6223.0	333.99	.....	.....	.....	11.00	12733.0	416.20	7.45	9634.0	394.39
Av.	.....	5607.2	300.54	.....	.....	.....	.....	11098.2	387.15	.....	9740.6	387.79
Diff.	.....	48.26	3.66	.....	.....	.....	.....	790.12	39.21	.....	1136.0	48.46

Total production under the two plans of testing. In Herd Testing the one day's milk weights are used in computing the production for the month. In our private herd records we use the actual weights of milk for computing the month's production.

In arriving at the average annual production of the herd, we use the method followed by the D.H.I.A., in computing herd averages. That is, the month or fraction of the month the cow is in the herd during the calendar year is used to determine the cow-years and not the exact number of days. Every cow is included in the average whether she was milked twenty or three hundred days during the year so long as she remained in the herd.

Not all Breed Associations report herd averages, and those which do, do not report all cows, for one reason or another. In the case of the college Brown Swiss Herd, the Association year begins in October, whereas our private record-year begins January 1.

In tables 3 and 4, are recorded the milk and butterfat as reported under the two systems of collecting samples and computing the monthly production. The Guernsey Association does not report herd averages. In the case of the Holstein Association some cows are omitted for one reason or another, and as previously stated the Brown Swiss Association terminates its testing year on the college herd in October. These variations in computing herd averages explain the wider differences with some breeds between the production reported by the Breed Associations and the college records. It is significant that the total milk and butterfat for the Jersey herd, for eight years should agree so closely. If similar comparisons with the other breeds were possible and would show as close agreement between the one day's weight of milk and the actual daily weights of milk, there is good reason for accepting the one day's milk weights as representing the true milk production for the testing period. When comparisons are made with the various years on the Jersey herd it is observed that larger differences obtain. The greatest difference occurred in 1935. The Herd Registry Test reported an average for the College Jersey herd of 5,690 pounds of milk, and 299.12 pounds of butterfat. Our private herd records based on composite tests and actual weights of milk totaled 5,332.2 pounds of milk and 282.38 pounds of fat. On the basis of 11.8 cow-years the average difference per cow is not important.

CONCLUSIONS

1. It would appear from these data covering a period of eight years, and 443 cows that the three-day composite test is as accurate as the test of fresh milk samples even when no effort is made to take aliquot portions of the milk in making composite samples.

2. That weight of milk for a single day can be used to determine the milk production for the month providing the cow is normal on the day of the official test.

3. That composite samples of milk and one day's weight of milk from each cow is a saving in time and cost in Herd Testing which is fully justified.

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VITAMIN A ACTIVITY OF MILK AS RELATED TO PASTURE AND FEEDING PRACTICES IN ALABAMA[1]

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The chief source of vitamin A for livestock is the yellow pigment, carotene, which occurs in greatest abundance in pasture crops and to a lesser extent in hay and silage. Guilbert, Miller and Hughes (6) have concluded that about 25 micrograms of carotene per kg. of body weight represents the minimum requirement for cattle, sheep and swine. They suggest, however, that the practical minimum is 5 to 10 times the physiological minimum. Converse and Meigs (2) state that for normal calving, cows should receive 80 to 100 milligrams of carotene daily during the last months of gestation. Ward, Bechdel and Guerrant (15) have concluded that the daily carotene requirement of growing calves is 11 micrograms per pound of body weight. For the production of milk rich in vitamin A, however, the carotene requirement of dairy cattle is greatly increased. This is accentuated by the very low percentage transfer of carotene to the milk, which has been reported to range from 2.38 to 2.67 per cent (4) and from 0.14 to 0.72 per cent (9).

Because of the tremendous losses of carotene during the curing and storage of hays and the making of silage, winter rations for dairy cattle are low in carotene. Consequently, the milk and butter produced in winter is much lower in vitamin A activity than that produced in summer.

The ineffectiveness of alfalfa hay and sorghum silage for maintaining a high level of vitamin A in butter was demonstrated by Kunerth and Riddell (12) who found that a Holstein herd receiving alfalfa hay and sorghum silage with little or no pasture produced butter with only half the usual vitamin A content. Fraps, *et al.* (4) found that A.I.V. sorghum silage had little effect on the vitamin A content of butter.

Some attempts to increase the vitamin A activity of winter butter have met with success. Hodgson, *et al.* (8), and Archibald and Parsons (1) found that when grass silage was fed to dairy cattle, the vitamin A in the butter and milk was increased significantly, but not to a level comparable to that produced on summer pasture. Johnson, *et al.* (10) were able to raise the vitamin A content of winter milk from 330 to 430 micrograms per quart by feeding phosphoric acid-alfalfa silage and to 510 micrograms per quart by feeding molasses-alfalfa silage. These values are considerably lower than those reported for summer milk.

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[1] A preliminary report of this work was presented at the 20th Annual meeting of the Southern Division, American Dairy Science Association, Memphis, Tennessee. 1942.

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Deuel, *et al.* (3) found that when cows were fed large amounts of vitamin A in the form of shark liver oil, they produced milk rich in vitamin A.

A review of the literature failed to reveal any economical feeding practice by which the average dairy farmer can produce milk in winter as rich in vitamin A as that produced in the summer. Climatic conditions in the southern part of the United States favor a long grazing period, and it is practicable to produce pastures suitable for grazing during the winter. The possibility presented itself, therefore, that by proper pasture practice, milk could be produced in the winter which would be as rich in vitamin A as that produced in the summer. The experiments reported in this paper were planned, therefore, to determine: (1) the seasonal variation in the vitamin A content of milk produced in the South under generally used feeding practices, (2) the value of the commonly used roughages as sources of carotene during the winter, and (3) the effect of temporary winter pastures on the vitamin A content of winter milk.

EXPERIMENTAL

Method for the determination of carotene and vitamin A in milk. All of the milk from the morning milking of a group of cows was thoroughly mixed to insure uniform distribution of the fat. A sample of milk was then taken and analyzed the same morning it was obtained. The following method was used for the determination of carotene and vitamin A:

One hundred grams $\pm$ 0.01 gm. of milk was weighed into a 500-ml. Erlenmeyer flask and 100 ml. of aldehyde-free 95 per cent ethyl alcohol and 50 ml. of 60 per cent by weight of aqueous KOH were added. The mixture was refluxed on a boiling water bath for 10 min. and cooled under a water tap. The solution was transferred to a separatory funnel and extracted once with 250-ml. and twice with 50-ml. portions of peroxide-free ether. The ether fractions were combined, extracted 4 times with an equal volume of water and dried over anhydrous sodium sulfate. The ether solution was then evaporated to dryness on a water bath under reduced pressure. Just as the ether was completely evaporated, the flask was immersed in a 70° C. water bath for 30 seconds to remove traces of moisture. The flask was allowed to cool for several minutes under vacuum. A small amount of chloroform was then introduced into the flask before the vacuum was released. The unsaponifiable residue was transferred to a volumetric flask and diluted to 10 ml. with dry chloroform. Carotene and vitamin A determinations were made on aliquots of this solution by means of a photoelectric colorimeter. The details of the procedure have been published previously (11). The calibration curve used for the vitamin A determinations in this study was obtained with crystalline vitamin A alcohol[3] and the results were recorded in terms of micrograms of vitamin A.

[3] The crystalline vitamin A alcohol was obtained from Distillation Products, Inc., of Rochester, New York.

Method for the determination of carotene in forage. The Peterson, Hughes, and Freeman (14) modification of the Guilbert (5) method was used for the determination of carotene in forage. Large samples of hay were reduced in a hammer mill to sufficient fineness to permit accurate subsampling. A representative sample was then finely ground in a Wiley mill. Fresh pasture clippings were finely cut with scissors for sampling and the sample used for the carotene determination was finely ground with sand. In the determination of carotene in silage, diacetone was used as suggested by Hegsted, *et al.* (7).

Moisture determinations were made on all of the forage samples, and the results of the carotene determinations were recorded on the dry weight basis.

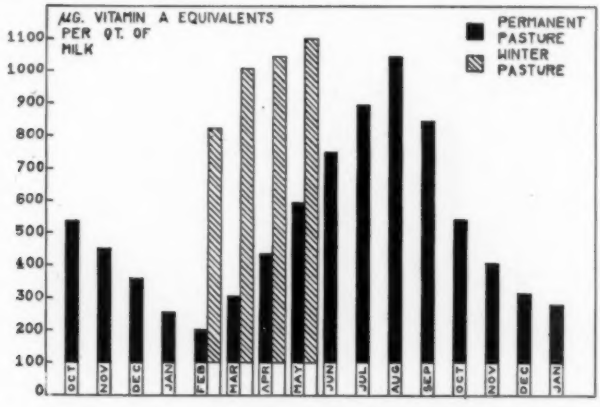

FIG. 1. Seasonal variation in the vitamin A activity of milk as related to pasture practice. The vitamin A activity is the sum of the vitamin A and carotene values expressed as μg-vitamin A equivalents assuming that 2 μg of carotene are equivalent to 1 μg of vitamin A.

Seasonal variation in the vitamin A activity of milk. To determine the seasonal variation in the vitamin A activity of milk produced in this section of the country, monthly samples of milk were taken from the College dairy herd of pure-bred Jerseys. This herd was kept throughout the year on a permanent pasture consisting mainly of carpet grass, Bermuda grass and lespedeza. They were fed a grain mixture consisting of corn 20, oats 20, wheat bran 20 and cottonseed meal 40 per cent, and received peanut hay and sorghum silage when the permanent pasture afforded scant grazing.

The results of this study are presented in table 1 and figure 1. The total vitamin A activity of the milk decreased from 535 micrograms per quart in October to 200 micrograms in February. The vitamin A activity then increased to a peak of 1045 micrograms per quart in August and rapidly decreased to the winter level again.

Effect of temporary winter pasture on the vitamin A content of milk. A two-acre winter pasture was sowed in Italian and abruzzi rye and crimson and white Dutch clovers on September 29th. This pasture was ready to be grazed on February 1st, at which time two cows from the College herd were turned into it. Within two weeks, the vitamin A activity of the milk produced by these cows increased fourfold. This increase continued until in May when the vitamin A activity of the milk reached a level higher than that produced by the College Herd at any time that summer. The results of the vitamin A and carotene determinations of the milk produced by the cows on this temporary pasture are given in table 1 and figure 1.

TABLE 1

Monthly changes in vitamin A and carotene content of milk as related to pasture practice (October 1939–January 1941)

Month	Permanent pasture only		Permanent pasture supplemented by temporary winter pasture February to May	
	Micrograms per quart of milk		Micrograms per quart of milk	
	Vitamin A	Carotene	Vitamin A	Carotene
October	342	380	.....	.....
November	276	348	.....	.....
December	220	280	.....	.....
January	167	170	.....	.....
February	150	100	450	740
March	202	200	430	1150
April	255	350	450	1180
May	335	510	500	1200
June	410	680	.....	.....
July	465	850	.....	.....
August	535	1020	.....	.....
September	385	920	.....	.....
October	305	470	.....	.....
November	270	270	.....	.....
December	220	180	.....	.....
January	200	160	.....	.....

After the first month of grazing, the growth of the pasture herbage became so luxuriant that other cows were allowed to graze on it to prevent the plants from maturing too early. All of the cows were removed from the pasture in May.

Effect of different roughages on the vitamin A content of winter milk. Groups of cows were put on the following rations late in the fall and vitamin A determinations were made on the milk at monthly intervals.

Group 1. Cottonseed hulls, grain mixture, permanent pasture.
2. Silage, grain mixture, permanent pasture.
3. Alfalfa hay, grain mixture, no pasture.
4. Lespedeza sericea hay, grain mixture, no pasture.
5. Peanut hay, silage, grain mixture, permanent pasture.

6. Same as 5 except 5 lbs. of Porto Rico sweet potatoes replaced an equal amount of silage.
7. Same as 5 except temporary oat pasture replaced permanent pasture.
8. Same as 5 except temporary rye pasture replaced permanent pasture.

The results of the vitamin A and carotene determinations made on the milk produced by these groups of cows in mid-winter are shown in table 2 and figure 2. Sorghum silage, permanent pasture, and alfalfa hay had little effect on the vitamin A activity of the milk. The alfalfa hay was very poor in quality. Peanut hay and lespedeza sericea hay which were of better quality than the alfalfa hay caused a very slight increase in the vitamin A

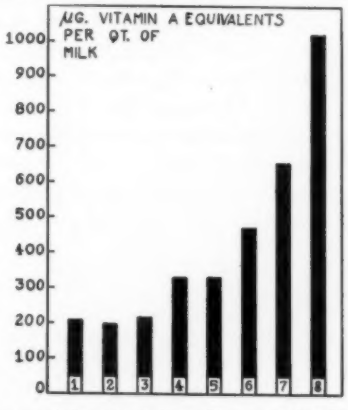

FIG. 2. The vitamin A activity of winter milk as related to feeding practices. The numerals at the base of the bars refer to groups of cows which received rations described in the text. The vitamin A activity is the sum of the vitamin A and carotene values expressed as µg-vitamin A equivalents assuming that 2 µg of carotene are equivalent to 1 µg of vitamin A.

activity of the milk. The feeding of 5 lbs. daily of Porto Rico sweet potatoes caused an additional increase of about 40 per cent. When the permanent pasture was replaced by an oat pasture, the vitamin A activity of the milk doubled, and when a rye pasture was used it increased three fold. The oat pasture did not afford as much grazing as the rye because of unusually cold weather which stunted its growth.

The carotene content of the forages used in these experiments is given in table 3. The determinations were made on the plants from the temporary pasture at the time they were being grazed and on the grasses from the permanent pasture when they were at their peak in growth and again when they began to dry up in the fall. Determinations were not made in the winter on the permanent pasture because the carotene content was too low

TABLE 2

Vitamin A and carotene content of winter milk as related to different roughages in ration

Group	Roughage	Micrograms per quart of milk	
		Vitamin A	Carotene
1	Cottonseed hulls	165	84
2	Sorghum silage	146	96
3	Alfalfa hay	156	114
4	Lespedeza sericea hay	294	70
5	Peanut hay, sorghum silage	202	256
6	Same as 5 except 5 lbs. sweet potatoes replacing silage	278	384
7	Same as 5 plus oat pasture	285	750
8	Same as 5 plus rye pasture	440	1160

for accurate analysis. The carotene content of the plants in the temporary winter pastures was greater than that of the grasses in the permanent pasture at the height of their growth. The carotene content of the grasses in the permanent pasture decreased markedly in the fall because of the dry weather. After frost the permanent pasture plants became dormant and contained practically no carotene.

If no winter grazing is available, roughages such as hay or silage must be relied upon as sources of carotene. The results of the analyses given in

TABLE 3

Carotene content of forages, dry weight basis

Forage		Date analyzed	Carotene content
			mg./100 gm.
Winter pasture	Crimson clover	2/28	37.7
	" "	4/ 1	41.2
	White Dutch clover	3/24	42.9
	" " "	4/ 7	47.22
	Abruzzi rye	2/28	56.5
	" "	4/ 7	64.6
	Italian rye	2/24	38.7
	" "	4/ 1	60.6
	Oats	2/24	36.2
	"	4/ 1	48.5
Summer pasture	Bermuda grass	8/20	30.1
	" "	11/20	4.2
	Carpet grass	8/20	28.4
	" "	11/20	10.0
	Lespedeza (common)	9/20	21.9
	" "	10/20	17.0
Other feeds	Sorghum (before ensiling)	9/11	4.61
	Sorghum silage	12/14	1.45
	" "	5/ 1	1.00
	Alfalfa hay	2/ 5	1.08
	" "	7/29	3.06
	" "	12/14	0.86
	Lespedeza sericea hay	12/14	1.04
	Sweet potatoes, Porto Rico	10/14	13.70

table 3 show that these forages are much lower in carotene than any of the fresh grasses. The ground sorghum is low in carotene when it is put into the silo. Upon fermentation considerable destruction of carotene takes place.

The inefficiency of hay as a source of carotene is shown in table 3. The alfalfa hay used in the feeding experiments, the results of which are given in table 2 and figure 2, contained only 0.86 milligrams per hundred grams. Most of the alfalfa hays on the market in this section of the country are of very poor quality and contain little carotene.

Porto Rico sweet potatoes contain a relatively large amount of carotene which explains why they significantly increased the vitamin A content of the milk when fed at the rate of five pounds per cow daily.

DISCUSSION

The vitamin A activity of milk produced by cows grazing on permanent pastures is dependent upon the degree of succulence of the forage. Unfortunately, the common permanent pasture grasses become mature and dry up in the fall, resulting in almost complete loss of the carotene. This condition exists until the pastures gradually recover in the spring. The fact that this variation in the carotene content of forage is paralleled so closely by changes in the vitamin A and carotene content of the milk, as shown in table 1 and figure 1, indicates that these cows did not store enough carotene and vitamin A to prevent a rapid decrease in the vitamin A activity of the milk in the winter. Even though the cows were ingesting tremendous amounts of carotene during the summer months, an immediate drop in the vitamin A activity of the milk was observed when the grasses began to dry up. It is also interesting to note that at no time of the year did the vitamin A reach a constant level in the milk. It appears that although large amounts of carotene were ingested during the summer, the limit of the cow's ability to secrete vitamin A into the milk was never reached.

It is obvious that in order to produce milk of high vitamin A activity throughout the year, dairy cattle must be fed rations containing large amounts of carotene at all times. Sorghum silage and hays do not contain enough carotene to prevent a rapid decrease in the vitamin A activity of the milk when adequate pastures are not available. Grass silage as stated by Johnson, *et al.* (10) is more efficient in maintaining the vitamin A activity of winter milk than sorghum silage and its use should be encouraged where it is impossible to have winter pastures. The making of grass silage, however, involves considerable expense which many farmers in this area may not consider justified. The use of temporary pastures is very economical and results not only in the production of milk and butter of very high vitamin A value but in increased milk production and increased thriftiness of the herd.

Dairy products furnish a considerable proportion of the vitamin A in the human diet. It is unfortunate that milk and butter produced in the

winter are low in vitamin A when the human diet is also low in other vitamin A rich foods. Moreover, at this time it is most needed to maintain resistance to respiratory infections. Moore (13) stated that one quart of milk is sufficient to meet the daily human requirement of vitamin A. His estimated requirement, however, is considerably lower than that recommended by the Committee on Foods and Nutrition of the National Research Council, which recommends that 5,000 I. U. (equivalent to 1,500 micrograms) of vitamin A be allowed daily to meet the adult requirement. The milk produced by the herd used in the present study was produced under feeding conditions considered excellent for this section of the country; yet only for 4 months of the year did one quart contain enough vitamin A to meet half the human daily requirement. In mid-winter the milk contained only one-seventh the amount of vitamin A needed to meet this requirement.

The results given in this publication show that it is possible by means of a temporary pasture to increase to eight months the length of time when one quart of milk will furnish at least half of the daily human requirement for vitamin A. The use of temporary winter pastures may not be possible in colder climates, but wherever possible, dairy farmers should take advantage of climatic conditions which favor the growth of winter forage crops.

It may be possible by careful selection and combination of forage crops to produce pastures which when grazed in rotation will furnish enough carotene throughout the year to eliminate completely the seasonal variation in the vitamin A activity of milk and butter. This possibility is now being investigated at this station.

SUMMARY

The vitamin A activity of the milk produced by a well-fed dairy herd varied from 200 micrograms per quart in February to 1,045 micrograms per quart in August. The vitamin A activity of the milk varied with the succulence of the pasture.

Feeding sorghum silage, or alfalfa hay or lespedeza sericea hay did not prevent a low vitamin A value of the milk produced in the winter.

Under common feeding and pasture practice, milk of high vitamin A value was produced for only 4 months of the year.

When cows were allowed to graze on a temporary pasture of rye and clover beginning on February 1st, the vitamin A activity of the milk increased from 200 to 1,050 micrograms of vitamin A per quart in 2 weeks.

The results of this work show that by the development of suitable winter pastures it is possible to extend to 8 months the period when one quart of milk furnished at least half of the daily human requirements for vitamin A.

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MICROSCOPY OF ICE CREAM WITH POLARIZED LIGHT[1]

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A technique for the examination and photomicrography of ice cream in which the identity, quantity, and grain size of the crystalline substances can be determined, and the textural relationship of non-crystalline materials and air cells observed, has been employed at the University of Missouri for over seven years with sufficient success to merit a description of it. By use of it, the ice, lactose crystals, and other constituents are determined directly in the ice cream in its normal structure and condition, *i.e.*, without melting, adding chemical reagents for testing, or otherwise introducing variables which may change the chemical, crystalline, or physical state before a critical test is applied. Further, because the determination is made using constant optical properties which arise from the internal atomic structure of the materials rather than on external shapes of crystals which vary with the environment of crystallization none of the uncertainties coincident with the latter method is encountered, and a background of physical crystallography is not a prerequisite. In fact, small particles with undeveloped crystal faces or broken fragments are preferred for study over larger crystals with modified faces.

The substance under examination is not destroyed by the observation, which is important. Products which are complex, like ice cream, portland cement, or rocks are studied by this technique, or if preferred their simpler constituent materials such as milk powder, the various sugars, crystals in cheese, or precious gems can also be equally well examined and determined. The method has been of wide application and acceptance in various scientific fields.

In short, the technique is a microscopical study in plane polarized light of a section of ice cream sufficiently thin to be non-opaque, and mounted or embedded in a liquid selected for an optimum index of refraction. The preferred microscope is the type used by mineralogists and petrographers, known as a petrographical microscope, in which polarizing prisms and accessory lenses particularly adapted to the study of crystals are regular equipment, but an ordinary chemical microscope which is available to most workers will, with certain polarizing additions, be satisfactory for most routine examinations.

HISTORICAL

In 1934, W. H. E. Reid and M. W. Hales found their progress on the study of the crystalline structure of ice cream retarded because of the diffi-

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[2] Associate Professor of Geology, who proposed the technique used.

culty in studying ice cream sections using air as a surrounding medium. The methods of ice cream microscopy used by earlier investigators, including those of Brainerd (2), Hall (7), Dahlberg (4), Cole (3), Dahle and Bradley (5) did not give the desired results, and in search of a new approach the two investigators consulted with the Geology Department where optical crystallography has been in use for many years in the identification of minerals and rocks. An advanced and well established petrographical technique proposed by the senior author was applied with appropriate modification to the first stages of "ice cream petrography" or crystal structure study. The results were immediate and successful. Extensive research on factors affecting the crystalline structure in ice cream and allied problems in Dairy Science has been conducted by using this technique, part of which has been published. Other problems involving polarized light microscopy are in progress of investigation at the Missouri Station at the present time.

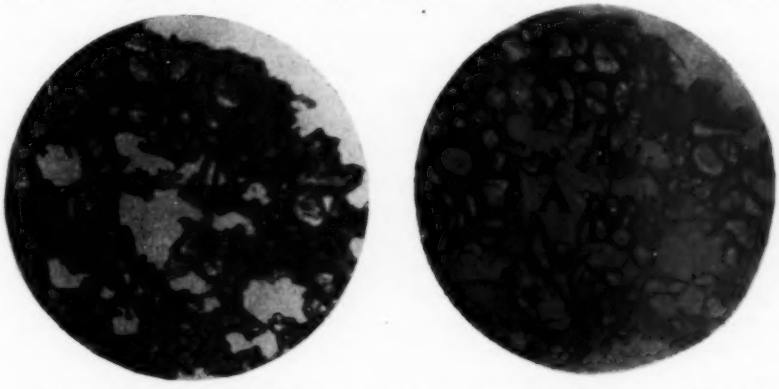
DESCRIPTION AND APPLICATION OF THE TECHNIQUE

The first step in the application of petrographical technique to thin section study of ice cream was the use of a liquid mounting or immersion medium for the ice cream thin section between the glass slide and cover slip in order that the index of refraction of the mounting medium could be adjusted closely to the indices of refraction of ice cream and be far above that of air, which had served as the mounting "fluid" heretofore. The detail made visible by this expedient is apparent in comparing Photomicrographs No. 2 and No. 1.

Number 1 shows a thin section of ice cream in air, whereas No. 2 is an identical view of the same thin section surrounded or immersed in ethyl acetate having an index of refraction of 1.372 (70° F.). The detail brought out in No. 2 is notable. In it crystals of ice are prominently visible within a matrix of non-crystalline fat, serum, sugars, and other milk substances. Air cells in the ice cream, a bubble in the liquid, and an area outside the section are also easily recognizable. The ice crystals were identified by their optical properties by Keller (8) and Arbuckle (1). The matrix material varies in optical properties with differences in the original mix, age, thermal history, acidity, and other factors contributing toward sandiness or crystal growth. Work in progress is revealing interesting facts about this matrix material.

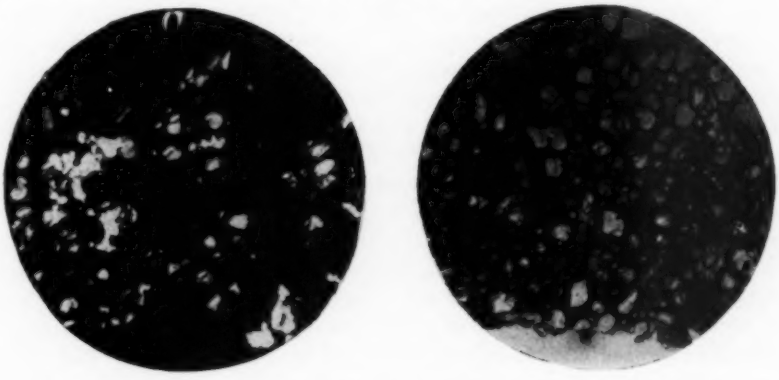
It is obvious that for general examination of a thin section of ice cream an immersion liquid whose index of refraction is intermediate between those of matrix and ice, like ethyl acetate, should be employed. If one having the same index as that of the matrix is used the matrix disappears but the remaining constituents become more prominent. Similarly, liquids of other indices of refraction may be chosen so that various constituents be suppressed visually and the others brought to view. Lists of liquids and their

indices are published by the Eastman Kodak Company, Larsen and Berman (9), or Winchell (11). Optical mineralogists ordinarily work with sets of liquids varying from 1.400 to 1.770 in index of refraction in graduation of .010, the range being obtained by blending inexpensive alcohols, kerosene,



Photomicrograph No. 1. Ice cream thin section surrounded by air. Magnification, 70 ×.

Photomicrograph No. 2. Identical section as in photomicrograph No. 1, surrounded or imbedded in ethyl acetate. I, ice crystals; A, air cells; M, matrix material.



Photomicrograph No. 3. Lactose-containing "sandy" ice cream photographed between crossed Nicols. Light grains are lactose, dark grains are ice crystals. Magnification, 70 ×.

Photomicrograph No. 4. Identically same view as in photomicrograph No. 3 except taken in ordinary light—uncrossed Nicols.

mineral oil, and others. Certain alcohols must not be used in ice cream work because they will dissolve or melt the frozen material even at – 15° F. Other liquids which are corrosive, poisonous, or offensive in odor may be avoided.

Resulting from microscopical study to date, Reid and Hales (10), Decker, Arbuckle and Reid (6), and Arbuckle (1) have shown from identifications, textural studies, and statistical analyses that smoothness, temperature-palatability, and other properties desirable to the consumer, as well as the influence of processing and variation of any of the components of the mix are correlated with size and number of ice crystals, air cells, inter-crystal and cell spaces. These measurements can be expressed quantitatively when made microscopically, and for these purposes the microscope is indispensable.

Thin sections are best prepared in the hardening room by sectioning the ice cream from a freshly cut surface with a thin, safety razor blade held in a detachable holder. Either the temperature of the hardening room should be brought down to −15° to −18° F. or, if it is held warmer, the ice cream samples must be chilled colder than −15° F. with a local refrigerant like dry ice. At warmer temperatures the ice cream becomes too gummy for sectioning. Because of friction in a microtome at these low temperatures none has served satisfactorily as an ice cream sectioning machine. All slides, blades, wiping cloths, immersion fluids, microscope and lighting equipment are cooled before commencing work. Certain adjustments of habit are required to do careful work, particularly microscop at low or below zero temperatures, but after some practice efficiency is attained.

The discussion thus far has been limited to observation in transmitted ordinary light, or plane polarized light if a petrographical microscope is used. For determinative analytical work plane polarized light must be used in order that control may be exercised over the direction of vibration of light entering the crystal or substance to be measured optically. Ice, for instance, possesses two indices of refraction measurable in vibration directions at right angles to each other. This type of crystal is properly oriented; or out of a group of crystals, one with proper orientation with respect to the controlled vibration direction of the light is selected, and the corresponding index of refraction is measured by comparison with a standardized index liquid. The second index of refraction of the ice is obtained at right angles to the first. Unknown substances are determined by measuring their indices of refraction and then looking up their values in key tables of optical constants.

Other crystals of the type exemplified by most sugars, including lactose, have three indices of refraction, each at right angles to the other. For comparison the indices of alpha lactose, beta lactose, and sucrose are given in the table below.

Material	*Refractive indices*		
	alpha	*beta*	*gamma*
alpha lactose	1.517	1.553	1.555
beta lactose	1.542	1.572	1.585
sucrose	1.540	1.567	1.572

It is apparent that no confusion will result from identification of each sugar or of differentiation between it and the others.

A third type of material includes the non-crystalline substances and the crystals of the isometric system. They have only one index of refraction but show no interference colors when viewed between crossed Nicol prisms. They remain dark whereas the ice or lactose types are more or less brilliantly lighted or colored. Therefore, in a thin section of ice cream, the same as in a melted drop of it, the lactose stands out as bright points, "stars," or clusters against a dark background when examined between crossed Nicols and is therefore most easily recognized, or studied for size and distribution. The immediate cause of sandy texture, or the variety of sandiness is almost instantly recognized. Because brilliant interference colors are seen in this test a natural color photomicrograph is really needed to illustrate it justly.

Although monochrome reproduction is drab in comparison to the original, Photomicrograph No. 3 is offered to show the light lactose crystals associated with dark, barely distinguishable ice crystals and matrix as photographed between crossed Nicols. Photomicrograph No. 4 shows identically the same view in ordinary light. Lactose is practically unrecognizable under this condition. In passing, it should be noted that large size lantern projections in natural color (or monochrome) from 35-mm. film photographs of typical thin sections become available for investigational, instructional, or sales purposes.

Further, in addition to the benefits derived from a direct eye study of ice cream, a definite, quantitative record of it can be kept for precise comparison with other specimens or with the same mix after aging. The personal factor in organoleptic tests or memory of them is removed. It becomes apparent that application of the technique of the petrographer to many products of dairy manufacture supplies a long needed tool to the investigator and control laboratory man.

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A QUANTITATIVE STUDY OF HEAT LABILE SULFIDES OF MILK. I. METHOD OF DETERMINATION AND THE INFLUENCE OF TEMPERATURE AND TIME[1, 2]

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Studies on the heat volatile sulfides of milk have assumed especial importance since relatively recent work has been reported indicating that the liberation of these sulfides and the formation of sulfhydryl groups may be closely allied with the production of the cooked flavor (6, 7, 11); with the heat prevention of the oxidized flavor in milk (5, 6, 7, 11) and cream (2); with the irradiated or burnt flavor (4); and with the spangling and purpling of cans in the case of sterilized cream (9, 10). The results secured in these various sulfide studies have been based largely on qualitative determinations. Therefore, it was for the purpose of securing quantitative data dealing with (a) the heat labile sulfides of milk and milk products and (b) with the factors influencing these sulfides that the experiments reported in this series of papers were conducted.

The liberation of hydrogen sulfide when milk is subjected to relatively high temperatures is now well established. A comprehensive review of early work on this subject is given by Gould and Sommer (7).

In qualitative experiments, lead acetate paper or cotton soaked in lead acetate solution has been used by a majority of the investigators, including Oppenheimer (15), Rettger (16), Gould and Sommer (7), and Gould (5, 6). Oppenheimer detected no sulfides when milk was held 30 minutes at 75° C., and Rettger was unable to detect hydrogen sulfide liberation until the temperature exceeded 85° C. Using rather large volumes of milk, Gould and Sommer (7) detected the liberation of sulfides when milk was heated to 76 to 78° C. momentarily, to 74 to 76° C. for 3 minutes, or to 70 to 72° C. for 30 minutes. Positive nitroprusside tests were obtained on milk heated to similar temperatures by Josephson and Doan (11) and later by Gould (6), indicating the formation of sulfhydryl groups.

The results of the limited quantitative studies which have been conducted on the heat labile sulfides of milk vary appreciably, due probably to differences in the methods used for liberation and detection and, also, to differences in the temperatures to which the milk was subjected. Oppenheimer (15) in 1901 measured sulfide liberation by means of lead acetate paper and

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obtained from 3 to 6 mg. of sulfur by boiling 300 ml. of milk for 30 minutes. In 1927, Konig and Schreiber (13) boiled milk 4 hours in an atmosphere of nitrogen and collected the volatile sulfur in a train containing a silver solution. By this procedure they obtained 3.8 mg. of sulfur per liter of milk.

More recent quantitative studies have been reported by Diemair, Strohecker, and Keller (3) and Flake, Jackson, and Weckel (4). Diemair, Strohecker, and Keller added 6 ml. of 1 per cent NaOH to 10 ml. of milk and distilled over the volatile sulfur. Recovery was made in a mixture containing a hydrochloric acid solution of p-amino-dimethylaniline and a nitric acid solution of ferric chloride. The intensity of the methylene blue produced was measured photometrically. Raw milk liberated 0.13 to 0.15 mg. and pasteurized milk 0.11 to 0.14 mg. sulfur from 100-ml. samples.

Flake, Jackson, and Weckel (4) in connection with studies on the activated flavor, utilized a vacuum distillation method and recovered and measured the liberated sulfides according to the method of Diemair, Strohecker and Keller (3). Temperatures of 74 to 75° C. and 77 to 79° C. liberated 0.0011 and 0.0036 mg. sulfur respectively from 350 ml. of milk.

In general, increasing the temperature between the range of 76 to 90° C. has been found to result in increases in the sulfides liberated as detected qualitatively (7). Furthermore, 30 minutes increases in the period of exposure to these temperatures have also been found to give increased sulfide liberation. However, Rettger (16) observed that upon prolonged heating of milk a point was reached at which hydrogen sulfide was no longer evolved. More recently, Hutchinson (8) also found prolongation of the heating period to result in a cessation of the liberation of sulfides. This investigator evaporated milk to dryness on a water bath at a temperature of approximately 96.5° C. and observed that further heating on the water bath did not appear to drive off additional sulfides.

Hutchinson (8) also studied the influence of high temperatures on the liberation of sulfur compounds by drying milk samples on a water bath and then subjecting them to temperatures of 105° C. to 450° C. for successive 30-minute periods in a muffle furnace. The total sulfur content of the samples was used as a basis of determining the sulfur changes which occurred. The results secured by this harsh treatment indicated that further sulfide liberation occurred until a temperature of 350° C. was reached above which no appreciable changes occurred.

The liberation of sulfides from milk persists for a relatively long period of time following their formation by the action of heat. For example, Gould (6) demonstrated that a positive nitroprusside test persists and hydrogen sulfide is evolved throughout a 6-hour aspiration period from milk previously heated momentarily to 90° C. Josephson and Doan (11) secured positive nitroprusside tests throughout 144 hours on milk flashed at temperatures above 80° C.

EXPERIMENTAL PROCEDURE

Milk used in this study was obtained directly from the college herd, the samples being secured and handled in well-tinned or glass containers to avoid metallic contamination.

Heating of the samples to temperature below boiling was accomplished in a water bath. Unless otherwise stated, the samples were placed in a round-bottom flask and agitated with a glass-rod stirrer or by aspiration with nitrogen or air. Approximately 15 minutes were required to bring the samples to the desired temperature, and temperatures were controlled within an accuracy of $\mp 0.5°$ C. Cooling to approximately 22° C. was accomplished with cold water within 5 minutes.

High temperature heat treatment of the milk, *i.e.*, temperatures above boiling, was obtained by means of a steam autoclave. Cans used in certain

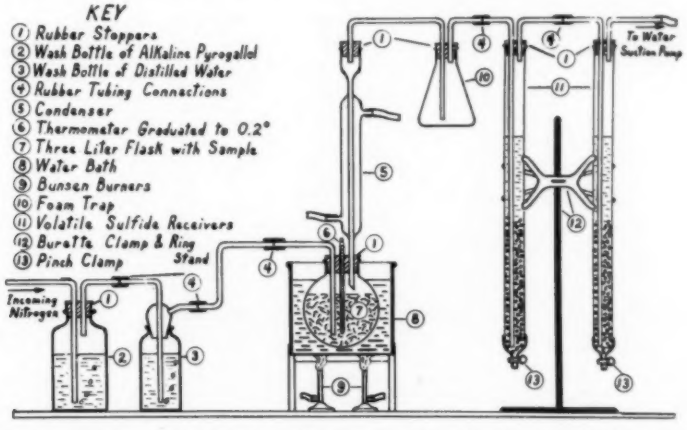

FIG. 1. Diagrammatic sketch of the apparatus used for the quantitative determination of volatile sulfides.

of the heat trials were No. 2 Canco, plain sanitary cans (American Can Company). Approximately 15 minutes were required to reach the desired pressure. Following heating, the samples were cooled by immediately transferring the container to cold running water.

After conducting a number of preliminary trials involving the use of colorimetric and titration methods for the quantitative determination of volatile sulfides, the Sheppard and Hudson (18) modification of the Almy (1) method with some additional variations was adopted. Kirilenko (12) has shown this method to give an accuracy of 0.001 per cent when used to determine the sulfides of gelatin. The method involves the collection of the liberated sulfides in alkaline zinc acetate and then the production of methylene blue by the addition of p-aminodimethylaniline and ferric chloride. The intensity of the blue color varies directly with the amount of sulfides.

Alkaline zinc acetate was prepared by adding 25 ml. of a 20 per cent stock solution of zinc acetate and 40 ml. of 10 per cent sodium hydroxide and diluting to a liter with distilled water. The indicator solutions consisted of a 0.1 per cent p-aminodimethylaniline (Eastman Kodak, No. 1333) in 1:1 hydrochloric acid and 0.02 molar ferric chloride (hexahydrate) in 4 per cent hydrochloric acid.

The apparatus used for the quantitative determination of volatile sulfides is diagrammatically shown in figure 1. The quantitative procedure involved the heating of a 2-liter sample in a 3-liter flask suspended in a water bath. Moderate agitation was produced and the evolved gases were carried off by passing nitrogen gas through the sample. In every case, the aspiration was continued not only during the heating period but for 30 minutes thereafter. Thus, the sulfide values reported represent the sulfides liberated during the heating period and for a 30-minute period during and after cooling.

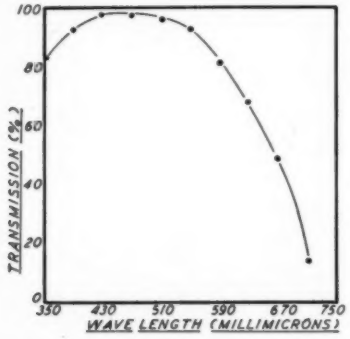

FIG. 2. Typical transmission curve of a representative color standard of known sulfur content.

Before passing through the sample, the nitrogen was purified by bubbling through alkaline pyrogallol and distilled water. The rate of nitrogen flow through the sample was regulated so as to give about 5 bubbles per second in the distilled water. The alkaline pyrogallol was prepared as recommended by the Chemist of the U. S. Steel Corporation (18), whereby 300 grams of pyrogallic acid are dissolved in a liter of distilled water and 2.5 volumes of 50 per cent sodium hydroxide added. Rubber stoppers used in the apparatus were boiled in strong sodium hydroxide solution prior to use and the rubber tubing used was sulfur-free. Blank determinations with distilled water showed the apparatus to be free of sulfur.

In order to recover the volatile sulfides, the nitrogen was conveyed to two receivers, 50 cm. in height and 20 mm. in diameter. Each receiver was half-filled with 4-mm. glass beads and contained 75 ml. of the dilute alkaline zinc acetate. Preliminary trials revealed that practically all of the sulfides were removed in the first receiver.

At the end of the aspiration period, the solution and glass beads were removed from the receivers and the receivers were rinsed with distilled water and then with dilute hydrochloric acid. The acid rinse was withheld from the alkaline receiving solution to avoid the possibility of an error due to the liberation of hydrogen sulfide before the indicators were added. The rinsings were then added to the alkaline zinc mixture, along with 25 ml. of the diamine reagent and 5 ml. of ferric chloride. The flask was immediately stoppered and a few minutes allowed for color development. The blue solution was then placed into a 300-ml. volumetric flask, the beads and flask rinsed several times with distilled water, the rinsings added to the volumetric flask, and then the volume made up to 300 ml. with distilled water. The solution was permitted to stand for several hours (usually overnight) to permit the maximum intensity of color to develop, and then the intensity

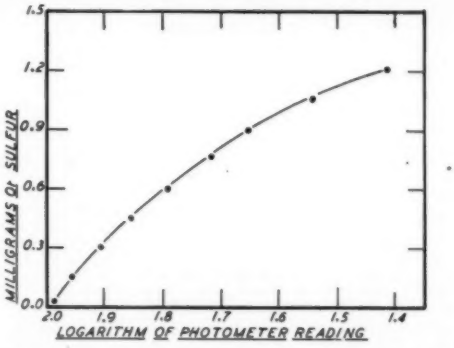

FIG. 3. Standard curve from prepared solutions of known sulfur content.

of the color determined with an Evelyn Photoelectric colorimeter, using a 620 Rubicon filter.

The filter showing maximum light transmission at a wave length of 620 millimicrons was selected after finding that the representative color standard exhibited maximum absorption at a wave length between 600 and 700 millimicrons when observed with a Cenco-Sheard Spectrophotelometer. The typical transmission curve is shown in figure 2. Although, theoretically, a filter with maximum transmission at a longer wave length may have been desirable, the source of light in the photometer was a limiting factor.

The known color standards were obtained by a variation of the Lachele (14) procedure. Accurate amounts of Standard Sample 14 C Bureau of Standards basic open-hearth steel were placed in the sulfide apparatus and 50 ml. of 1:1 hydrochloric acid were added. The acid alone gave a perfect blank. The sample was gently heated until dissolved and then boiled for 5 minutes. Nitrogen gas was passed through the system during the heating period and for 10 minutes thereafter. The hydrogen sulfide thus produced

was collected in the receivers. The blue color was developed as previously described, and photometric measurements obtained. Photometer readings were obtained of the color standards produced from steel samples containing amounts of sulfur ranging from 0.03 to 1.5 mg. The standard curve for values up to 1.2 mg. is shown by figure 3.

The nitroprusside test was conducted according to the method described by Gould (6) adapted from the method of Josephson and Doan (11).

EXPERIMENTAL RESULTS

Momentary heating. Trials were conducted in which milk was heated momentarily to temperatures from 72° C. to 90° C. Results are presented in table 1. As previously noted, these values represent the sulfides liberated during the heating and for a subsequent 30-minute aspiration period. Although some variation occurred between the individual trials, in general, no

TABLE 1

Volatile sulfur recovered from milk heated momentarily to various temperatures

Temperature	Trial Number						
	1	2	3	4	5	6	Average
°C.	*mg./l.*	*mg./l.*	*mg./l.*	*mg./l.*	*mg./l.*	*mg./l.*	*mg./l.*
72	0.000	0.000	0.000	0.000	0.000	0.000	0.000
74	0.000	0.000	0.003	0.000	0.006	0.012	0.004
76	0.021	0.010	0.008	0.004	0.019	0.045	0.018
78	0.025	0.012	0.011	0.010	0.024	0.060	0.024
80	0.053	0.045	0.030	0.083	0.037	0.068	0.053
82	0.068	0.075	0.075	0.098	0.060	0.083	0.077
84	0.099	0.120	0.083	0.115	0.088	0.099	0.101
86	0.130	0.139	0.120	0.136	0.119	0.133	0.130
88	0.210	0.210	0.210	0.235	0.193	0.158	0.203
90	0.260	0.210	0.230	0.285	0.254	0.199	0.240

appreciable sulfide liberation occurred until approximately 76° C. was reached. This is in line with qualitative results previously reported (7). Average results show that sulfur recovered as volatile sulfide amounted to 0.018 mg. per liter at 76° C., 0.053 mg. per liter at 80° C., 0.130 mg. per liter at 86° C. and 0.240 mg. per liter at 90° C.

Holding period. In additional trials and using somewhat similar temperatures, milk was held for 0, 30, and 60 minutes and the sulfides liberated during these heating periods and for the subsequent 30-minute period were measured. Results are presented in figure 4.

The sulfide values are decidedly lower for the momentary heating trials than those in table 1, especially so at the higher temperatures. However, the data do reveal that prolonging the heating period at all temperatures excepting 95° C. increases the sulfide liberation. At this temperature, however, no appreciable difference in sulfide liberation occurred between the 30-minute and 60-minute periods although there was a marked difference

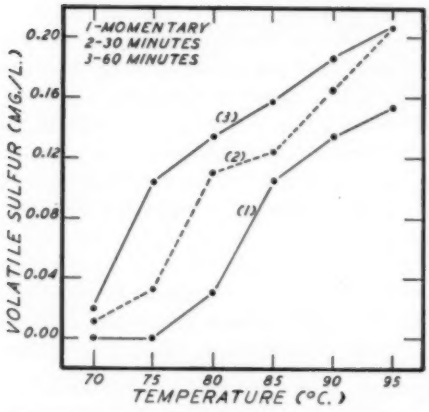

FIG. 4. Sulfide liberation from milk heated at temperatures of 70–95° C. for 0, 30, and 60 minutes.

between the 0-minute and 30-minute periods. Increasing the holding period likewise decreases the critical temperature for sulfide liberation. Positive nitroprusside reaction was secured in all cases where sulfide liberation occurred. In general, the nitroprusside tests became progressively more positive the longer the holding time or the higher the heating temperature.

Previous heat treatment. To determine the influence of previous low-temperature heat treatment upon the formation of heat labile sulfur, milk was subjected to temperatures of 50 to 60° C. for 30 minutes and from 62 to 79.5° C. momentarily. Following this process, the milk was cooled and then the volatile sulfides determined by heating the milk momentarily to 90° C. The sulfides liberated were collected in the usual manner during this latter heat treatment and for 30 minutes thereafter. The results are shown in table 2.

TABLE 2

Influence of previous low-temperature heat treatment upon the subsequent liberation of sulfides from milk heated momentarily to 90° C.

Previous heat treatment		After heating to 90° C.
Temperature	Holding time	Volatile sulfur
°C.	*minutes*	*mg./l.*
Control	.....	0.232
50.0	30	0.215
55.0	30	0.215
60.0	30	0.225
62.8	0	0.215
68.5	0	0.226
73.6	0	0.218
79.5	0	0.202

The heat treatments previous to the volatile sulfide determination ranged from slightly under to slightly over the critical temperature. The data in table 2 indicate that when milk is exposed to temperatures slightly below the critical temperature, the sulfides subsequently volatilized did not vary appreciably from the normal value. However, when milk is heated to slightly above the critical temperature (79° C.), the subsequent sulfides evolved show a marked decrease. It would appear therefore that the normal low temperature pasteurization of milk does not affect the liberation of sulfides which occurs at higher temperatures.

Prolonged and high temperature. Studies were conducted to determine the influence of prolonged exposure of milk to 95° C. upon (a) the quantity of sulfides liberated during 30 minutes of aspiration after cooling, (b) the nitroprusside test, (c) the cooked flavor, and (d) the extent of discoloration.

TABLE 3

Influence of heating milk for prolonged periods at 95° C. upon the liberation of sulfides, the nitroprusside reaction, the cooked flavor and the discoloration

Period of exposure to 95° C.	Volatile sulfur	Nitroprusside test*	Flavor	Browning*
minutes	*mg./l.*			
0	0.158	4	Cooked	0
5	0.165	4	"	0
15	0.192	4	"	0
30	0.203	4	"	0
60	0.208	3	Caramel	0
90	0.091	2	"	1
120	0.060	1	"	1
150	0.053	1	"	2
180	0.012	?	"	3
210	0.000	?	"	4

* Intensity indicated numerically: 0 = no coloration, 4 = strong coloration.

In these trials, a 2-liter sample of milk was placed in a 3-liter flask and agitated with a motor-driven glass stirring rod while being exposed to 95° C. for the indicated period. Results presented in table 3 represent the volatile sulfides liberated during 30 minutes of aspiration subsequent to heating and cooling.

Data in table 3 reveals that increasing amounts of sulfides are made available by exposing milk to 95° C. for periods up to 60 minutes. However, when the samples were exposed to 95° C. for periods of 90 minutes or longer the quantity of sulfides liberated is progressively decreased and, after 210 minutes of exposure, sulfide liberation was no longer detectable. Under these conditions and with this particular milk, the total sulfide liberation amounted to 1.142 mgs. per liter, with 0.926 mg. or 81.1 per cent being evolved during the first 60 minutes.

Sulfhydryl groups also decrease with increases in exposure time at 95° C. above 60 minutes. However, after long exposure, the milk itself had become sufficiently discolored so as to make questionable any nitroprusside test.

Results in table 3 also show that a change in flavor and in the color of milk occur at approximately the time at which decreases in sulfide liberation and in the intensity of the nitroprusside reaction occur. A strong cooked flavor was observed in samples held for periods ranging from 0 to 30 minutes. However, at the 60-minute period a slight caramel flavor, similar to that of evaporated milk, was observed and this flavor became progressively more intense with prolongation of the holding time. Also, milk became discolored at approximately the 90-minute period, and this discoloration or browning likewise became more noticeable with continuation of the heat treatment.

Additional studies were conducted to determine the influence of prolonged heat treatment of milk placed in varied types of containers. In these

TABLE 4

Influence of the type of heating container upon the sulfides obtained from milk held at 90° C. for different periods of time

Period of exposure to 90° C.	Sealed cans	Open cans	Sealed jars*	Agitated in open flasks
minutes	*mg./l.*	*mg./l.*	*mg./l.*	*mg./l.*
0	0.107	0.132	0.125	0.130
30	0.088	0.166	0.175	0.170
60	0.040	0.178	0.183	0.178
90	0.006	0.121	0.129	0.110
120	0.000	0.095	0.097	0.093
150	0.000	0.064	0.061	0.060
180	0.000	0.033	0.031	0.027
210	0.000	0.006	0.009	0.006
240	0.000	0.000	0.000	0.000

* Although these glass jars were sealed in the usual manner, the rubber gaskets did not maintain the pressure that developed during heat treatment.

trials, milk was sealed in 18-ounce Canco cans and in quart Mason glass jars, and other portions were placed in open 18-ounce Canco cans and in an open flask. The open cans were used in order to ascertain if the cans, themselves, contributed any influence on the sulfide liberation. All of these samples were heated at 90° C. for periods from 0 to 240 minutes. After cooling to room temperature the volatile sulfides were collected during 30 minutes of aspiration. Results are presented in table 4.

These values reveal little difference between the sulfide liberation in open cans, sealed glass jars, and open flask. In all of these, the quantity of sulfides increased up through the 60-minute period, but decreased thereafter. In contrast to these results, the milk in the sealed cans gave a lower sulfide value at the 0-minute period and evolved lower quantities of sulfides upon continued heating. In fact, in this sample, sulfide liberation had practically ceased after 60 minutes of heating.

Values of the total amount of sulfide liberation are of especial interest. A total of 0.241 mg. of sulfur per liter was liberated from the sealed-can

samples as contrasted to 0.795, 0.810, and a 0.744 mg. per liter evolved from the open-can, sealed-jar, and open-flask samples respectively. After 30 minutes of heating, 80.9 per cent of the total volatile sulfur had been evolved from the sealed-can sample whereas a similar period of heating liberated approximately 37.8 per cent of the total volatile sulfur in the other three lots.

The lack of similarity between samples heated in sealed cans and sealed glass jars (which did not hold pressure) indicated that pressure which developed in the can during heating plays some significant role in causing the disappearance of the volatile sulfur compounds.

The influence of high heat treatment on the sulfide liberation, the nitroprusside reaction, the flavor and color of milk was ascertained by heating

TABLE 5

Influence of high heat treatment upon the heat labile sulfides

Heating temperature	Holding period at heating temperature	Volatile sulfur	Observations after heating		
			Nitroprusside test	Cooked flavor	Browning
°C.	*minutes*	*mg./l.*	Sealed cans		
90.0	0	0.110	3	4	0
90.0	20	0.096	3	4	0
108.3	20	0.045	2*	4	1
126.6	20	0.010	1*	3†	2
126.6	30	0.000	1*	3†	3
			Glass jars		
90.0	0	0.138	4	4	0
90.0	20	0.170	4	4	0
108.3	20	0.052	3*	4	?
126.6	20	0.012	2*	3†	2
126.6	30	0.000	1*	3†	3

* Results not reliable due to off-color of milk.
† Not a typical cooked flavor, but a slight caramel or evaporated milk flavor.

milk in sealed cans and in sealed glass jars to temperatures ranging from 90° C. to 126.6° C. Data are shown in table 5 which represent the sulfides liberated for a 30-minute period following heating.

These results again reveal that at 90° C., when the sealed can is used, the amount of sulfides evolved at 0-minute is less than the case of a sample heated in the glass container that does not hold the pressure. Furthermore, additional heating of the sealed-can samples, even for 20 minutes, lowers the volatile sulfide content whereas in the glass-jar sample the sulfide liberation is increased.

Additional information supplied by the data in table 5 is that high temperature heat treatment alone, as produced by pressure heating, will also destroy the property of milk to evolve sulfides. When temperatures above boiling were utilized, sulfide liberation of the milk was adversely affected to

approximately the same degree irrespective as to whether or not the sealed can or the glass jar were used. A temperature of 108.3° C. for 20 minutes lowered the sulfide value by approximately 60 per cent under that secured by heating momentarily to 90° C. The use of 126.6° C. for 20 minutes reduced the sulfide liberation to about 9 per cent of the 90° 0-minute value, whereas this temperature for 30 minutes completely prevented sulfide liberation.

Results in this table also show the nitroprusside reaction to be decreased with decreases in the sulfide liberation, although the color of the reaction was obscured by the browning of the milk in cases of prolonged heating. Furthermore, the change in flavor of the milk from a cooked to a caramel flavor and the production of browning correlated well with those temperatures at which marked lowering of sulfide liberation occurred.

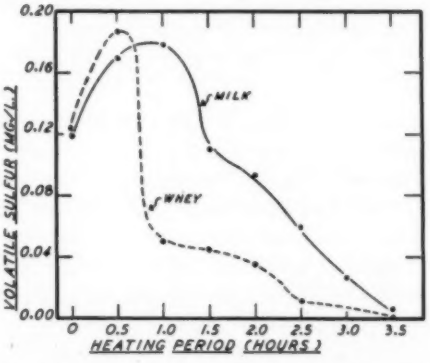

FIG. 5. The influence of prolonged heating of milk and rennet whey at 90° C. upon the sulfide liberation.

Heat treatment of whey. The decrease in sulfide liberation of milk heated for more than 60 minutes at 90–95° C. and the browning of milk at approximately this same time, indicated that casein may play a role in producing the sulfide decrease. That such apparently is not true is illustrated by figure 5 in which rennet whey is heated for prolonged periods at 95° C. For comparative purposes results are presented of other trials involving milk. The results for whey follow a similar trend shown by the milk, but with the whey exhibiting a decrease in sulfide liberation after a shorter heating period than was observed in the case of the milk.

Persistency of sulfide liberation. To determine the tenacity with which the volatile sulfides created on heating are retained by the milk, milk was momentarily heated to 90° C. and the sulfides evolved measured during heating and at 30-minute intervals throughout a 4-hour aspiration period. The results are shown in figure 6.

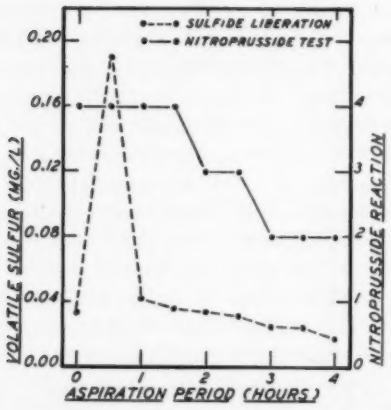

FIG. 6. Liberation of sulfides and changes in the intensity of the nitroprusside reaction when milk was aspirated for a prolonged period following a 90° C. heat treatment.

This figure reveals that only a relatively small portion (0.033 mg. per liter) of the total amount of volatile sulfur is evolved during the 15 minutes necessary to bring the sample to 90° C. whereas the largest portion is evolved during the first 30 minutes of aspiration. Sulfides continued to be liberated throughout the 4-hour period with the last 30-minute period giving an average volatile sulfur value of 0.019 mg. per liter. The total sulfur liberated by the milk amounted to 0.434 mg. per liter, with 0.223 mg. per liter being evolved by the end of the first 30 minutes of aspiration.

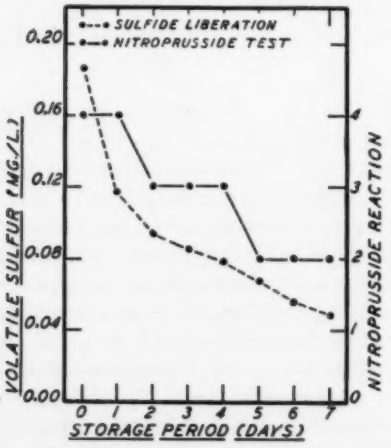

FIG. 7. Liberation of sulfides and changes in the intensity of the nitroprusside reaction when milk was stored for 7 days following a 90° C. heat treatment.

In additional studies on the persistency of the sulfide liberation, milk was heated to 90° C. and stored at 5° C. for 7 days. At daily intervals, a portion of the milk was aspirated for 30-minute periods and the volatile sulfur collected and measured. Results of the sulfide liberation and the intensity of the nitroprusside reaction are shown in figure 7.

The figure reveals that appreciable sulfide liberation occurs throughout the entire 7-day period, with values for each successive day being somewhat smaller. The intensity of the nitroprusside test also decreased with decreases in the sulfide liberation.

DISCUSSION

The method used in this study for obtaining the sulfides from dairy products is purely arbitrary and, in general, represents the sulfides liberated from the sample during the heat treatment and during a subsequent period of 30 minutes. It is recognized that the results secured by this procedure do not necessarily represent all the sulfides that were formed by the heat treatment or those that may be formed and liberated through subsequent chemical rearrangement in the sample. However, this method was chosen since it was believed desirable to secure results representing the sulfide liberation when the milk was under normal conditions and not when it had been subjected to abnormal chemical treatment nor to abnormal methods of distillation.

That all of the sulfides ultimately liberated by aspiration after the heat treatment are not included by the procedure followed, is indicated by the fact that milk heated to 90° C. continued to evolve sulfides for more than 4 hours thereafter when subjected to continued aspiration. In fact, according to these results, the method adopted actually recovered approximately 50 per cent of the total volatile sulfur evolved throughout the 4-hour aspiration period. The question arises as to whether all of the sulfides ultimately liberated after the heat treatment are immediately formed or whether they continue to be formed over a relatively long period of time by further rearrangements of the reduced sulfur compounds created by the heat treatment. The average value of 0.024 mg. per liter for sulfide liberation of milk at 78° C. is higher than the 0.0104 mg. reported by Flake, Jackson, and Weckel (4) for temperatures of 77–79° C. However, differences within various milks would easily account for this variation, since individual samples gave sulfide liberation varying from 0.010 to 0.060 mg. per liter at this temperature.

The observation that reduced sulfur compounds, formed in milk upon heating, may be made to disappear by additional heating has especial application to the evaporated milk industry. The role pressure plays in this phenomenon is also of interest. Furthermore, the fact that browning of the milk and the development of a caramel or evaporated milk flavor occurs

almost simultaneously with the reduction in hydrogen sulfide and the decrease in sulfhydryl compounds indicates a possible relationship between these changes. Although casein doubtless is involved in the browning of milk, it apparently is not involved in the reduction in the volatile sulfur content.

CONCLUSIONS

The heat volatile sulfides of milk are measured quantitatively by aspirating the milk with nitrogen during the heat treatment and for 30 minutes thereafter, collecting the liberated sulfides in alkaline zinc acetate, producing methylene blue by the addition of a hydrochloric acid solution of p-aminodimethylaniline in the presence of ferric chloride, and measuring the intensity of the blue color photometrically.

Quantitative studies are presented of milk heated for 0-, 30-, and 60-minute periods at approximately 70–95° C. Under these conditions, an increase either in time or in temperature increased the volatile sulfur values and decreased the critical temperature. Although variations occurred between different milks, the liberated sulfur for six samples averaged 0.018, 0.053, 0.130, and 0.240 mg. per liter when the milk was heated momentarily to 76, 80, 86, and 90° C., respectively.

Prolonged heating of milk at 90 to 95° C., heating milk for a short period at this temperature range in a sealed can, or heating milk for a short period to temperatures above boiling decrease the sulfide liberation or prevent it entirely.

A possible relationship is indicated between the decrease in the hydrogen sulfide liberation, the production of a caramel flavor, and the browning of milk.

ACKNOWLEDGMENT

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INFLUENCE OF LENGTH OF DRY PERIOD UPON THE QUANTITY OF MILK PRODUCED IN THE SUBSEQUENT LACTATION

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The length of dry period most favorable for milk production in the subsequent lactation has never been definitely determined. Arnold and Becker (1) found, from a limited amount of data, indications that a dry period of 1 to 2 months was enough to allow maximum production, that a dry period longer than 3 months was not beneficial, and that a dry period shorter than 1 month lowered production. The conclusions reached in this report agree with the findings of Arnold and Becker and, due to the number of records and the method of analysis used, somewhat more precise information was obtained.

In addition to determining the influence of the length of dry period upon the production of milk in the subsequent lactation, the writers attempted to ascertain the optimum length of dry period by comparing the loss of milk in the current lactation with the gain in the following lactation.

Dickerson and Chapman (2) compared production records of lactations following dry periods of different lengths with those of the first lactation and found that low producing cows showed a higher percentage increase through lengthening the dry period than did high producing cows.

The source of the material for this study was 15,442 lactation records of dairy herd-improvement association cows, collected from 12 States. The average production of these cows was about 10,000 pounds of 4 per cent milk, the bulk of them falling within the range of 7,500–12,500 pounds. In this study comparisons were made only between the production records of the same cow following dry periods of different lengths. No comparisons were made between different cows. The proportion of the total number of lactation records that could be used was rather small because, in order to find out the effect of the dry period upon the subsequent lactation, it was necessary to use the last part of one lactation period to determine the approximate length of the dry period and another lactation period of the same cow immediately following to determine the production of milk. Furthermore, the same cow had to have for comparison another record made following a dry period of a different length. This meant that to permit one comparison the cow had to have 3 consecutive lactation records, or 4 if there was a break

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following the second lactation. Even with these limitations, 1,139 comparisons were obtained.

The exact date on which the cows went dry could not be obtained. For this reason the comparisons were made on a monthly rather than on a weekly or daily basis. For example, a dry period of less than 1 month was compared with a dry period of 1 to 2 months, 1 to 2 months with 2 to 3 months, 2 to 3 months with 3 to 4 months. Similar comparisons were made between dry periods having greater differences in their lengths as 0 to 1 with 2 to 3 and 1 to 2 with 3 to 4 months. The records were converted to a mature basis by using DHIA factors (3).

The effect of dry period on milk production was expressed as a percentage increase for each cow, using as the base the cow's average yield of 4 per cent fat corrected milk (mature basis). For example, if a cow's records average 10,000 pounds of 4 per cent fat corrected milk, mature basis,

TABLE 1

Increase in production following dry periods of greater length

Length of dry period compared, months		Number of comparisons	Average increase in production of 4 per cent fat corrected milk, mature basis	Probable error of column 4
Shorter	Longer		*per cent*	
0–1	1–2	432	9.19	0.64
1–2	2–3	474	4.34	0.55
2–3	3–4	56	1.60	1.54
0–1	2–3	86	13.49	1.59
1–2	3–4	91	5.51	1.45

and she produces 500 pounds more milk following a long dry period, than following a short dry period, the increase would be 5.0 per cent of 10,000 pounds. The percentage increases of the individual cows falling into a particular dry period range were averaged and the figure so obtained was considered to represent the difference in production following that change in dry period.

To eliminate the influence of differences in the calving interval upon the production, an adjustment of the records to the same calving interval in accordance with unpublished factors prepared in the Bureaus of Dairy Industry and Agricultural Economics was made. It should be stated, however, that the length of the calving interval could be determined for only 960 of the 2,278 records used in this study. The same adjustments were made for calving interval on those of unknown length as on those of known length. In other words, the intervals of known length were considered representative of all. Possibly the adjustment for calving interval could have been omitted had it not been found that there was a distinct negative

correlation between the length of dry period and the length of the interval between the next 2 calvings. A long dry period was generally followed by a short calving interval and vice versa. Possibly a reason for this is that cows with long dry periods may have had breeding trouble and did not calve at the season desired. Then they were bred earlier the next time in order to regain the lost time.

An analysis of variance test was worked to find out if there were any distinct variations between States. As none were found it was decided to pool the records from all the States. Table 1 gives the results.

Thus it was found that by increasing the dry period from 0–1 month to 1–2 months, the yield of 4 per cent fat corrected milk was increased by 9.19 per cent; that is, the average cow that produced 10,000 pounds of 4 per cent fat corrected milk with a 0–1 month dry period would produce

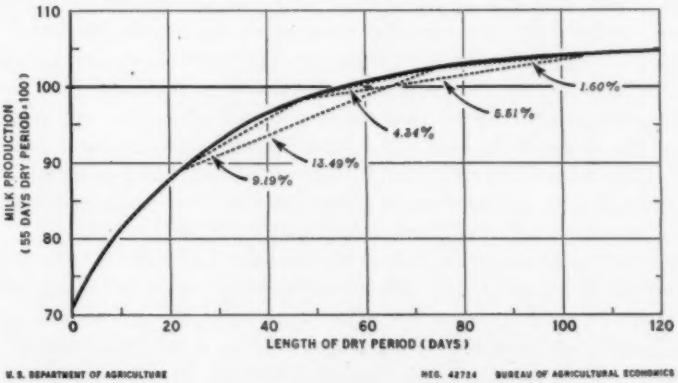

FIG. 1. The increase in milk production associated with increase in dry period.

10,919 pounds of 4 per cent fat corrected milk with a 1–2 month dry period.

It will be noticed that the internal agreement of the percentage figures is much better than their probable errors would indicate. For example, the increases from 0–1 to 1–2 and from 1–2 to 2–3 were 9.19 and 4.34 respectively, which added together give an increase of 13.53 per cent. This is very close to the 13.49 per cent found by direct comparison of the 0–1 and 2–3 month intervals. Also, the sum of the increases from 1–2 to 2–3 and from 2–3 to 3–4 is 5.94 per cent, which again is fairly close to the 5.51 per cent increase obtained by a direct comparison of 1–2 and 3–4 month intervals.

Although most of these records did not give the exact date of drying off, there were a few (about 200) that did. It was found that the 0–1 month group averaged 22 days dry; the 1–2 month group, 47 days; the 2–3 month group, 75 days; and the 3–4 month group, 104 days.

Since this was a selected group it gives no positive information concerning the entire 1,139 cows. However, the figures look quite reasonable,

because the average of each group is close to the midpoint of that group except for the 0–1 month group. By assuming that the actual number of days dry found with the 200 cows is representative of the entire 1,139 cows, it is possible to fit a smooth mathematical curve and interpolate quite accurately in terms of days.

Figure 1 and table 2 show the results of table 1 when making the above assumption. The figure was drawn so that 55 days dry would be equal to 100 per cent. It will be shown later that the greatest production, considering both the loss in the current lactation and the gain in the following lactation, occurs when cows calving at 365 day intervals are dry approximately 55 days. A diminishing returns curve is fitted to these points.[1] The equation of the diminishing returns curve used is $Y = M - AR^x$.

Almost any curve would fit the data satisfactorily from 25 up to 100 days dry period, and it is within this range that the factors (table 2) will be most useful. But the essential assumption underlying the curve used is that the increase in milk production per unit increase in dry period will steadily decline as the dry period becomes longer.[2] And since this assumption appears justified, some reliance may be placed on the extrapolations beyond the range of the data. For example, the curve indicates that cows given no dry period will only yield 71 per cent as much milk as with a 55-day dry period but no matter how long they are dry they would produce only 5.3 per cent more milk than with a 55-day dry period.

The factors given in table 2 apply without appreciable error only to the average of a large herd. The unexplained error of the comparison of two lactations of an average cow after adjustment for dry period, calving interval, age, and butterfat test (standardized at 4 per cent) was still 9.1 per cent.[3] This was due to the variation in milk flow caused by changes in feeds, differences in care of the cow, and various other factors not considered in this study. In these comparisons it was found that half[4] of the variation in milk production from one lactation to another after adjustment for age, calving interval, and standardizing to 4 per cent fat corrected milk, could be explained by dry periods, indicating the pronounced effect of changes in length of dry period on milk production within a herd where a farmer's practices in feeding and caring for the cow, *et cetera*, presumably remain much the same from year to year.

In table 2 we find the results of figure 1 in tabular form. These will serve as factors to convert to a 55-day dry period basis.

[1] The method of fitting was a least squares determination using $\frac{1}{\sigma 2}$ as the weights of the dependent variable. For a discussion of this method see Whittaker and Robinson, "The Calculus of Observations," Chap. IX, p. 220 and ff.

[2] For a further discussion of the curve, see W. J. Spillman, "Use of the Exponential Yield Curve in Fertilizer Experiments," Tech. Bul. 348, U.S.D.A.

[3] Probable error.

[4] The multiple correlation coefficient was 0.706.

OPTIMUM LENGTH OF DRY PERIOD

When a cow is turned dry, some milk is sacrificed, but the expectation is that by giving her a dry period of suitable length, the amount lost will be more than counterbalanced by the increased production in the next lactation. The problem was to determine the length of dry period of cows calving every 12 months that would result in the greatest production of

TABLE 2

Factors to use with dry periods of different lengths to convert total lactation yields to a 55-day dry period basis

Dry period	Milk production (55 days = 100)	Probable error*	Factor to multiply by to convert to a 55-day basis
days	*per cent*	*per cent*	
0	71.29†	0.43	1.403
5	76.59†	0.31	1.306
10	81.06†	0.21	1.234
15	84.83†	0.14	1.179
20	88.02†	0.10	1.136
25	90.71	0.07	1.102
30	92.98	0.05	1.076
35	94.89	0.04	1.054
40	96.51	0.03	1.036
45	97.87	0.02	1.022
50	99.03	0.01	1.010
55	100.00	0.00	1.000
60	100.82	0.01	0.992
65	101.51	0.02	0.985
70	102.10	0.03	0.979
75	102.59	0.04	0.975
80	103.01	0.05	0.971
85	103.36	0.06	0.967
90	103.66	0.07	0.965
95	103.91	0.08	0.962
100	104.12	0.09	0.960
105	104.30†	0.09	0.959
110	104.45†	0.10	0.957
115	104.58†	0.11	0.956
120	104.69†	0.11	0.955
.....	.....	.....	.....
.....	.....	.....	.....
275 days and over	105.27†	0.15	0.950

* In one-half the cases the absolute size of real error will be smaller than indicated by the probable error and the other half will be larger. In only one-twentieth of the cases will the absolute size of true error be larger than 3 times the probable error.

† Extrapolated.

milk when the loss in the current lactation is considered along with the gain in the next lactation. This is termed the optimum length of dry period.

To make this study, it was necessary first to construct a lactation curve for cows that had milked for 11 months or more and had calved again in about 365 days. Cows that had milked for shorter periods could not be used because no reliable estimate could be made of how much more milk they would have given if they had not been turned dry. It appeared from

the records that even some of the cows milking 11 months were turned dry instead of being allowed to go dry naturally. When selections were made on the basis of 360 to 370 days calving interval and a dry period of 30 days or less, it was found that 63 records were available.

In working out an average lactation curve for these 63 cows, the 4 per cent fat corrected milk produced for each of the 11 months was expressed as a per cent of the total 4 per cent fat corrected milk produced in the lactation, giving 693 observations. A smooth curve was then fitted to these percentages and extended by extrapolation to the twelfth month. A large

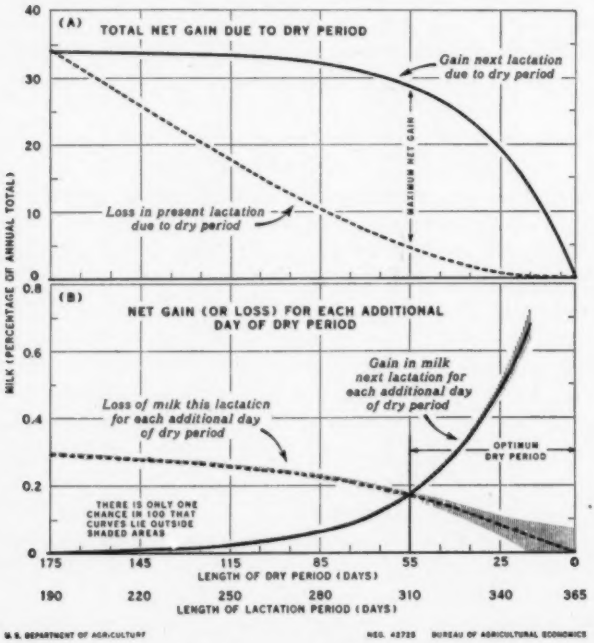
(A)
TOTAL NET GAIN DUE TO DRY PERIOD
Gain next lactation due to dry period
Loss in present lactation due to dry period
MAXIMUM NET GAIN
MILK (PERCENTAGE OF ANNUAL TOTAL)
40
30
20
10
0
(B)
NET GAIN (OR LOSS) FOR EACH ADDITIONAL DAY OF DRY PERIOD
Gain in milk next lactation for each additional day of dry period
Loss of milk this lactation for each additional day of dry period
OPTIMUM DRY PERIOD
THERE IS ONLY ONE CHANCE IN 100 THAT CURVES LIE OUTSIDE SHADED AREAS
0.8
0.6
0.4
0.2
0
175 145 115 85 55 25 0
LENGTH OF DRY PERIOD (DAYS)
190 220 250 280 310 340 365
LENGTH OF LACTATION PERIOD (DAYS)
U.S. DEPARTMENT OF AGRICULTURE
NEG. 42725 BUREAU OF AGRICULTURAL ECONOMICS

FIG. 2 (A) and (B). Length of dry period and its effect on milk production. Determination of the optimum dry period.

number of the cows gave milk also for part of the twelfth month, but were dried off. Thus the record for this month did not reflect production as it would have been if the cows had been allowed to dry off naturally.[5]

Table 3 and figure 2, A and B, illustrate the method of determining the optimum dry period. In column 3 of table 3 is shown the percentage of the total 4 per cent fat corrected milk that will be produced in the last 35,

[5] The curve was a least squares determination. The method outlined is that given in George W. Snedecor, "Statistical Methods," Chapter 14. The standard error of estimate was 1.26 per cent for individual observations.

45, *et cetera*, days of lactation by cows having a 365 day calving interval. Column 4 shows the gain in 4 per cent fat corrected milk which will be realized next lactation due to the beneficial effect of the dry period. Column 5 is the difference between columns 3 and 4, and represents the net gain due to dry period.

Figure 2, A, shows this in graphic form. The dotted line represents column 3 of table 3 and the solid black line represents column 4. The vertical distance between these lines represents the net gain due to dry period. It will be noticed that this net gain increases to 55 days and then decreases

TABLE 3

Determination of the optimum length of dry period by balancing the loss of milk in the current lactation against the gain in the subsequent lactation

Length of time		Total net gain due to dry period			Net gain caused by lengthening dry period 1 day		
To subsequent calving	From previous calving	Total 4 per cent fat corrected milk lost in present lactation*	Total 4 per cent fat corrected milk gained in next lactation†	Net gain due to dry period (4) less (3)	Loss in milk this lactation for each additional day of dry period‡	Gain in milk next lactation for each additional day of dry period§	Net gain obtained by allowing one more day in the dry period (7) less (6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
days	*days*	%¶	%¶	%¶	%¶	%¶	%¶
25	340	0.76	19.42	18.66	0.08	0.49	0.41
35	330	1.75	23.60	21.85	0.11	0.35	0.24
45	320	3.05	26.58	23.53	0.14	0.25	0.11
55	310	4.61	28.71	24.10	0.17	0.18	0.01
65	300	6.41	30.22	23.81	0.19	0.13	−0.06
75	290	8.40	31.30	22.90	0.21	0.09	−0.12
85	280	10.56	32.07	21.51	0.22	0.06	−0.16

* Obtained from lactation curve of 63 cows having a 365-day calving interval. Figures shown as the total milk produced within last 35, 45, etc., days before calving.

† Derived from curve $Y = M - AR^x$. Since $M - A$ is the milk production when no dry period is given, $Y - M - AR^x$ less $M - A$ equals $A(1 - R^x)$, which is the gain in milk next lactation due to dry period.

‡ Lactation curve of 63 cows where the milk production per day is shown.

§ Derived from curve $Y = M - AR^x$. A gain in milk for an additional day's dry period would be $Y_{1+1} - Y_1 = (M - AR^{x_{1+1}}) - (M - AR^{x_1}) = A(1 - R)R^{x_1}$.

¶ Percentage of total 4 per cent F.C. milk production (mature basis).

thereafter. It is evident that the optimum dry period is 55 days because at this point the net gain is greatest.

Columns 6, 7, and 8 permit the preparation of figure 2, B. This shows more clearly the exact length of the optimum dry period. Column 6 which is shown as a dotted line on figure 2, B, is the amount of the total 4 per cent fat corrected milk that the cows produced each day during the lactation. Thus a 10,000-pound cow produces 22 pounds her 280th day of lactation, and only 11 pounds her 330th day of lactation.

Column 7, which is shown as a solid black line on figure 2, B, is the gain in milk production next lactation caused by an additional day dry period. Thus, a 10,000 pound cow would produce 35 pounds more milk during her next lactation if her dry period is increased from 35 days to 36 days. However, she will produce only 6 pounds more milk if the dry period is increased from 85 days to 86 days. Column 8 shows net gain (or loss) per day, considering the effect of dry period on the present lactation together with the effect on the succeeding one. The optimum dry period will occur at that number of days where the gain in milk in the next lactation due to an extra day of dry period is just balanced by the loss in milk in the current lactation period, caused by drying off the cow one day earlier. This point is reached at a dry period of 55.8 ± 0.4^3 days. This is shown in figure 2, B, by the intersection of the two curves.

The shaded portions on figure 2, B, represent the zones of uncertainty in the curves. These zones are so drawn, on the basis of the sample under discussion, that there is only one chance in a hundred that the true curves will lie outside the shaded portion.

These figures make it clear that it would pay a farmer with good producing cows to standardize the dry periods as nearly at 8 weeks as possible, but if the dry period must be longer or shorter than this it is better to have it longer rather than shorter.

SUMMARY

From a group of 15,442 lactation records obtained from D.H.I. Associations in 12 States, 1,139 comparisons were made of the same cows having lactation records following dry periods of different lengths.

These records were converted to 4 per cent fat corrected milk and adjusted to maturity basis. They were then expressed as percentages of the average yield of 4 per cent fat corrected milk so as to reduce them to a common basis. Finally they were adjusted for differences in calving interval.

It was found that cows dry 1–2 months gave 9.2 per cent more milk than when dry 0–1 month; cows dry 2–3 months gave 4.3 per cent more milk when dry 1–2 months; and that cows dry 3–4 months gave 1.4 per cent more milk than when dry 2–3 months.

The exact date of drying off was known for 200 of the 1,139 cows. Dry periods of 0–1 month dry averaged 22 days, 1–2 months 47 days, 2–3 months 75 days, and 3–4 months 104 days. The application of these figures to the records of the 1,139 cows made it possible to represent quite accurately the influence of dry period on milk production by the equation $Y = 105.28 - 33.98 (.9667)^x$, where Y equals the per cent of average yield of 4 per cent milk, mature basis, and X equals number of days dry period.

A table for converting yields of milk to a 55-day period basis is presented.

A dry period of 55 days was found to be the optimum length for cows yielding 10,000 pounds and calving at 12-month intervals. Either a longer or a shorter dry period reduces the milk yield, the longer because more milk would be lost in the current lactation than would be gained in the following lactation, the shorter because more milk would be lost in the following lactation than would be gained in the current lactation.

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PAPERS PRESENTED AT THE ANNUAL MEETING

GENERAL PROGRAM

1. Utilization of the Milk Supply—Statement of the Problem. W. E. KRAUSS, Ohio Experiment Station, Wooster.

During a war emergency most efficient utilization of the food supply is of prime importance. Recognition of the importance of milk as a source of critical food nutrients directs particular attention to this product and hence to its most effective utilization.

Because of the special demands of military operations the usual distribution of milk among its various normal outlet channels has had to be modified and may need to be modified still further. Emphasis has been placed upon dried milk in order to meet restricted transportation space limitations. The great demand for skimmilk powder not only inaugurates international recognition of the high nutritive value of the solids-not-fat fraction of milk but creates competition between the utilization of skimmilk for livestock feeding on one hand and human feeding on the other.

Increased civilian, military and lend-lease demands for milk cannot be met without increasing production. With prospects for any material increase in milk production not too favorable it may be necessary to divert some of the 40 billion pounds of skimmilk now retained on farms into drying, evaporating and cheese plants in the form of whole milk in those regions where livestock feeding would not be jeopardized. The other alternative and one fraught with many difficulties and disadvantages, would be to restrict civilian consumption through rationing.

The following questions need to be carefully considered: How much skimmilk, buttermilk and whey actually are fed to livestock, and to what extent could such by-products be more effectively diverted to other uses? To what extent can feed-stuffs replace milk by-products in livestock feeding? How much skimmilk actually is wasted during the flush season?

Never before has the dairy industry been scrutinized so closely or been extended such a high degree of importance. Some of the changes inaugurated now as emergency measures more than likely will persist later. It is particularly important, therefore, to discuss all angles of the milk utilization problem.

2. Will the Pigs, Chickens, and Calves Miss the Skim Milk? L. A. WEAVER,* University of Missouri.

Because of the high value of dairy products particularly for feeding young-growing animals and the large tonnage of these produced and used

* In collaboration with Prof. H. L. Kempster and Dr. Harry A. Herman, Poultry and Dairy Departments, respectively, University of Missouri.

annually for feeding purposes, the answer to question presented is obviously "yes." More pertinent questions may be (1) how can limited amounts of skim milk be used to best advantage, (2) is skim milk indispensable in the diet of pigs, chickens and calves; and, (3) what effect will learning to get along with little or no milk have upon the demand for this product from feeders if and when the industry is in need of such a market?

Experiments have shown that maximum returns are secured from skim milk (1) when no more is used than that needed to balance the grain ration; (2) when it is used as a partial rather than a complete source of the nutrients required to supplement carbonaceous feeds; and finally (3) when its use is limited to small amounts, fed for a short time, during critical production periods.

Pork producers normally use a relatively large percentage of animal proteins in their rations and many believe that particularly for young pigs, for a short time following weaning, at least 25 per cent of the protein supplement should come from feeds of animal origin. A part of this small amount may well be skim milk although satisfactory results may be secured without the use of dairy products if some tankage, meat scraps, fish meal or similar feeds are available and especially if good pasture can be provided.

Much the same conditions prevail with poultry producers, that is a small amount of skim milk is a highly desirable adjunct to the diet, particularly for some classes of poultry but milkless diets have been formulated which give satisfactory results indicating that skim milk is not indispensable.

The young calf must have some milk in its diet during the first few weeks of life. Calves may be raised successfully by feeding whole milk for a short time, gradually switching to a dry calf starter containing as little as 5 per cent dried skim milk. When 4 months of age even this small amount may be eliminated from the grain mixture.

It appears then that it is possible for producers of pigs, chickens and calves either to do without skim milk entirely or limit its use to small amounts for a short time in critical production periods. However, producers probably consider the use of milkless rations as an emergency measure even though they have learned to do without or with only small amounts of this very valuable food stuff. Whether a more generous use will be made of skim milk at the end of the present emergency will no doubt depend upon the relative price of milk products and the substitutes they have learned to use considering, of course, differences in results secured when such exist.

3. Past, Present and Future of Dry Milk. ROUD MCCANN, director, American Dry Milk Institute.

The history of the dry milk industry covers a comparatively short space of time. At the beginning of this century milk drying was invented and the development of the industry has been much like the story of an unwanted orphan born with great opportunity.

Development of dry whole milk production has been tedious because of the skill required to insure the keeping quality of the fat. Many phases of this problem were eliminated with the removal of the fat, leaving the valuable non-fat constituents which comprise more than two-thirds of the total food solids of milk.

Each of the dry milk products—dry whole milk, defatted milk solids, cream, malted milk, feed skim milk, casein and whey—has its particular place in the total and advantageous utilization of the Nation's milk supply. Of these the development of defatted milk solids is probably most notable.

The value of milk fat has been so thoroughly implanted in the minds of the public and the percentage of water present in milk is so high, that recognition of the importance of the non-fat solids has been slow. The quicker the dairy industry seizes the opportunity to place higher proportionate values on the non-fat solids, the better for the producer, the processor, and the public.

The definition and name of the product resulting from the removal of fat and water from milk should be in such terms as not to depreciate the consumer's estimation of the utility values of constituents other than fat. Such legal designation is necessary for full development of domestic and foreign markets and for maintenance of farm value of fat and non-fat solids combined.

Concentrated in dry form, dry milks are easily and inexpensively shipped and stored, without need for refrigeration or danger of freezing. Processing costs under normal conditions compare favorably with other ways of utilizing milk. Food values, including the vitamins, are retained. All these characteristics, and more, distinguish dry milks as a splendid way to expand and extend the production and use of essential food constituents of milk.

The armed forces and lend-lease are wanting much of the dry whole milk of good quality now being produced—estimated up to 100 million pounds for 1943.

Approximately 400 million pounds of defatted milk solids are wanted for lend-lease and army needs this year. This figure is mounting with needs increasing in war-torn areas. 210 million pounds more would be needed by the domestic baking industry for the present 3 per cent requirement in bread —420 million if and when the requirement is raised to the desirable minimum—if all were to come from dry milk. Other civilian requirements, if kept to a minimum, would be at least 150 million pounds.

Now, when needs are so great, more attention should be given to procurement and utilization of all the milk, regardless of the form of dairy products in which consumed. More stable returns from dairy production are found in sections where the producer sells whole milk, and dairy products are of higher quality. The old controversy about milking cows to feed other animals is gradually being eclipsed by the greater efficiency in direct

utilization in the human diet. Herein the dry milk industry is playing an increasingly important role for the public good.

EXTENSION SECTION

REPORT OF COMMITTEE ON EXHIBITS AND METHODS

A. R. PORTER, Iowa State College, Ames

The committee consisting of Paul Carruth, C. J. Fawcett, R. J. Harris, O. J. Hill, and A. R. Porter, chairman, invited the extension dairymen of each state to bring or send exhibits of the ideas and methods being used in their states to the extension section meeting at Columbia, Missouri.

The following states indicated their intentions of having material to present:

Colorado

Iowa—"The More Milk Campaign." Copies of individual letters on production problems prepared by the Dairy Industry and Dairy Husbandry Extension Service and filled out by creameries and sent to their patrons with milk and cream checks.

Kansas

Massachusetts

Michigan—"Dairy Industry and Dairy Extension Service Cooperate to Achieve Increased Wartime Dairy Production." Folders and leaflets prepared by Extension Service and distributed through commercial dairies with milk and cream checks.

Minnesota—"The Cow Quiz Program."

Missouri—"Adjusted Programs for Wartime." 1. Volume Food Production: producing aids; 2. Quality Food Production: methods of securing high quality products under present conditions; 3. Farm Food Usage and Storage: contributions to the farm food supply by the production and full usage of cheese, butter, cottage cheese and milk in the home.

Nebraska—"Milk and Cream Improvement Program." Materials used in a program with the producers, buyers and processors to improve milk and cream quality.

New Jersey

Oregon—"Feeding Plans for Dairymen."

South Dakota—"Simplified Dairy Record Project." A plan for the owners to take samples and the creamery to make tests each three months to simplify production records.

Tennessee—"A Four-Point Program for Producing More and Better Milk."

Washington—"A Simplified Herd Record Book." A combination yearly and permanent herd record book has been developed. Ninety per cent of DHIA members have elected to use the new book.

Wisconsin

Michigan—"Dairy Industry and Dairy Extension Service Cooperate to Achieve Increased Wartime Dairy Production." Cooperation with commercial dairy companies has helped gain a larger Michigan dairy farm audience for the Dairy Extension Service, Michigan State College.

In October, 1941, Folder F4 entitled "It Takes Feed to Produce Milk" issued by the Extension Service, Michigan State College, was distributed through commercial dairies throughout Michigan with milk and cream checks.

The folder was sent to more than 70,000 dairy farmers. All agencies such as creameries, milk companies, condenseries, cheese factories and managers of other dairy concerns cooperated with Dairy Project Leader A. C. Baltzer in effecting this distribution.

In June, 1942, Extension Folder F23, "Good Pasture—Abundant Low Cost Feed for Dairy Cows," was similarly distributed to 70,000 patrons while in January, 1943, Extension Folder F49 entitled "To Keep 'em Milking—Keep 'em Fed" was placed with the milk and cream checks for 90,000 patrons.

Other inserts were developed including a graining—milk production ratio sticker, insert mimeographed leaflets or "Pasture Pointers for Dairy Defense" and "Increasing Milk Production for War Needs."

REPORT OF TESTING COMMITTEE

A. The Use of Conscientious Objectors as Dairy Herd Improvement Association Fieldmen. C. R. GEARHART, Pennsylvania State College, State College.

At the 1942 meeting of the American Dairy Science Association little time was devoted to the discussion, "Using C. O.'s for D.H.I.A. fieldmen." Selective Service had not released any C. O. boys for this work, and too there was some public sentiment against the use of such men for D.H.I.A. work.

The idea of using C. O.'s was called to our attention as early as the fall of 1941. In the spring of 1942 it was rumored that a few boys would be released for D.H.I.A. work in the states of Wisconsin, New York and New Jersey. Nothing came of this proposal and in June 1942, Selective Service announced that it was not considering the release of C. O.'s for the time being. In the fall of 1942 the use of C. O.'s was suggested again and we made plans to find out as much as possible about the C. O.'s, their attitude toward D.H.I.A. work and the association's attitude toward the use of such men. Between October 1942 and February 1943, contacts were made with the following agencies:

The Presidents of Juniata, Westtown College and George School

Dean of men at Swarthmore College

The Soil Conservation Representative who supervised the work projects of C. O.'s

Two C. O. Camp Directors

Three church organizations—the Friends, the Brethren and the Mennonites

Some objections to the use of C. O.'s were expressed but the majority of these agencies favored their employment in this field.

Letters were written to Selective Service and N.S.B. for R. O. and they replied favorably to the proposition.

In the meantime New Jersey was given three men on trial. These men began work as D.H.I.A. fieldmen in December 1942. Shortly after this time New Jersey was promised six additional men from C.P.S. camps in Michigan but for some reason these men were not released.

In February 1943, with the assistance of J. B. Parker of the U.S.B.D., interviews were arranged with Colonel Kosch of Selective Service, and T. E. Shearer of the N.S.B. for R.O. Arrangements were made for the release of 10 men and these men were sent to the Pennsylvania State College for a two week short course. All 10 of these men were employed at the close of the course. Since this time we have given two more short courses each of which was attended by seven C. O. men along with our other students. We now have a total of 24 C. O.'s employed by D.H.I.A. in Pennsylvania.

In addition to the 35 C. O. men employed as D.H.I.A. supervisors in New Jersey and Pennsylvania, many other states are requesting C. O. men; among them are Connecticut, Michigan, Indiana, New York, and Nevada. Forty-three additional men have been promised release for such work by Selective Service.

Our experience with these men has been very satisfactory. They are doing excellent work and the county agents and dairymen are well pleased with their conduct and interest in their work.

The Mennonite Committee Office, which supervises C. O. placement in Pennsylvania, reports that they are well pleased with the results accomplished here.

There are two important improvements which we hope to make.

1. We are trying to secure the release of these boys from their camps in time so that they can be here at the College for the opening of the courses. So far, boys have arrived late for each of our courses, due to the fact that they were released too late.
2. We hope to set up a program covering the following points:
   a. How to make requests for C. O. boys.
   b. How releases are made.
   c. How funds are handled.
   d. Obligations assumed by Associations.
   e. Privileges which may be granted the boys, such as leaves.

Our original agreement concerning the use of C. O. men was as follows: "That the association involved defray the expenses of transportation

from the camp in which the man may be located to the headquarters of the herd association and agree to pay the return transportation at the expiration of hostilities or at such times as the man's services prove unsatisfactory. In addition to this, the association must agree in writing to provide room, board, laundry, medical care and hospitalization when necessary and to provide the man with an allowance of $2.50 per month and transportation from farm to farm."

Due to changes in personnel and to a ruling by the Comptroller General's Office, the original plan was changed and improved. It now includes a flat amount to be paid each month to the N.S.B. for R. O. and 50¢ per day for personal expenses to the men.

Arrangements have been made for interviews with Selective Service, the Agriculture Labor Administration Board, the N.S.B. for R. O. and Bureau of Dairying following which I hope to have a definite plan for the use of C. O. boys in Pennsylvania. The final plan will be presented at the 1943 American Dairy Science Association Meeting.

A. Vocational Agriculture and Junior D.H.I. Associations in War-Time D.H.I.A. Adjustments. R. F. EVANS, University of Vermont.

Reports were received from 16 states relative to high schools, their students and their graduates assisting with D.H.I. work to help relieve the tester shortage and maintain dairy test records for farmers who might have otherwise been denied a method of continuing their herd records.

Four states reported the use of regularly organized Junior D.H.I. associations. Ten states reported no organization of this type.

Three states reported that high schools were carrying on project work in dairy herd testing which was supervised by the agricultural instructor on a private record basis (not official). New York reported they furnished 40,000 individual cow sheets annually for this type of work.

Six states reported using high school students on a temporary basis to help bridge the gap between the loss and replacement of a regular tester. However, four of these reported that this arrangement was not too satisfactory chiefly due to inadequate mathematics, transportation, and the pressure of other school activities.

Three states report the use of high school boys collecting the samples at the farm for central laboratories or for regular D.H.I. testers. Missouri reports considerable success with this method.

Ten states reported as cooperating in some way with the vocational agricultural school. Pennsylvania reports that the schools have aided them greatly in keeping the D.H.I. program going, their greatest contribution being that of locating prospective testers and sending them to the D.H.I. short courses.

Vermont organized 3 Junior D.H.I. associations in the fall of 1941 and 2 in 1942. Three associations have completed one year and two of these are

continuing another year. The records were well handled and the work proved successful, both from standpoint of the school and the farmers in the three associations which have completed a year.

We can definitely say that the high school boys, under the supervision of the agricultural instructor, have saved five of our regular associations which otherwise would have disbanded.

It is interesting to note that Wisconsin reports nearly 200 agricultural departments cooperating and testing 50,000 cows by this method.

In Vermont we find generally that our Junior associations provide training for the boys, provide practical material for the teacher to use in class, test herds that otherwise would not obtain records on their herds, and provide records that are much more useful than private records; but that they can never replace our regular associations other than to assist in an emergency.

B. Bi-Monthly Testing as a War-Time D.H.I.A. Adjustment. E. C. SCHEIDENHELM, Michigan State College.

Bi-monthly testing has been used in Michigan during the past 12 months as a means of maintaining the dairy herd improvement association program. On December 31, 1942, Michigan had 22 per cent of all the associations in the United States on bi-monthly testing according to a summary released by the Pure Bred Dairy Cattle Association. From a total of sixteen associations at one time on bi-monthly test there are now only six. Six disbanded for the duration due to a lack of personnel. A majority of the others have returned to the monthly plan. Reason given by breeders for disliking the bi-monthly plan are: 1. Sixty-eight per cent thought the work inaccurate due to the long interval between tests. 2. Thirteen per cent discontinued because of lack of feeding information. 3. Thirteen per cent did not want to be bothered with keeping up data such as breeding dates, dry dates, and calving dates over a two month period. 4. Only six per cent thought the cost too high for the service received.

Successful bi-monthly testing was continued where an old experienced supervisor was in charge of the work.

B. Combining Associations. FLOYD J. ARNOLD, Iowa State College, Ames.

In order to keep dairy herd improvement associations going, when supervisors started leaving the work faster than replacements could be found and trained, Iowa associations were asked to help one another. At a meeting of representative association members, County Extension Directors and D.H.I.A. Supervisors, a plan was worked out. In accordance with the plan associations agreed to loan their supervisors—one month at a time—to neighboring associations. (A copy of the agreement is available upon request.) This proved particularly helpful to associations left without a

supervisor near the end of the testing year, for it meant their records could be completed and summarized.

Cooperation between associations, which started with the loaning of supervisors, led quite generally to bi-monthly testing. Twenty-eight Iowa associataions—about one-third of the total number in the state—turned to bi-monthly testing in 1942. The drop in the number of associations during the year was 27 per cent, but the drop in the number of herds on test was only 13 per cent.

SIRE COMMITTEE REPORT

A. Some Factors Influencing Success in Field Artificial Insemination.

I. F. Elliott, G. W. Salisbury, and S. J. Brownell, Cornell University, Ithaca, N. Y.

Maintaining a satisfactory level of fertility is a problem of consequence to most dairy cattle artificial insemination associations; numerous factors are involved, a few of which will be considered here.

In New York, results are measured by the percentage of cows bred which do not return for further service. A considerable proportion of cows which do eventually return have not yet returned at the end of from one to two months after service. Records of one association indicate that 99 per cent have returned at the end of five months, however. A comparison of one and five month non-returns with actual calvings or diagnosed pregnancies will be made.

Periods of low fertility appear to occur in midwinter and in spring. This is not in agreement with most of the published work on the subject. In fact, one period of relatively high fertility falls in August and September in contrast with the fact that most investigators have found this to be a period of low fertility.

It appears that seasonal variation in semen quality may be less striking in central New York than in some states farther to the South. This may account for part of the above-mentioned deviation from the usual seasonal variation in fertility. Other possible causes will be discussed.

The selection of bulls from a fertility standpoint and the careful selection of individual semen samples are believed to be factors of primary importance in the maintenance of a good level of fertility. Over 35 per cent of bulls selected for use in one large circuit have been discarded due to unsatisfactory fertility, in spite of the fact that the previous breeding record and semen samples of each bull were carefully checked before the bull was put into service. The bulls culled were all beyond five years of age, and the average age was eight years.

When it is employed along with other routine laboratory measures, the methylene blue reduction test assists the technician considerably in the selection of semen samples for use.

Semen has been diluted to as much as one part of semen to sixteen parts of yolk-citrate diluter. These higher dilution rates have made for greater efficiency in the use of outstanding bulls of high fertility.

Treatment of bulls low in fertility has produced little in the way of positive results. Neither shark liver oil nor wheat germ oil when added to the regular rations, appeared to be of benefit. Chloretone treatment appears worthy of further investigation. Thyroprotein preparations have not been used.

C. The Value of Partial and Completed Lactation Records for Evaluating Dairy Cows.[1] WARREN GIFFORD, University of Arkansas, Fayetteville.

Difficulties encountered during the present War Emergency in securing records on dairy cows has increased the need for information concerning the value of records of partial lactations of various lengths for evaluating the individual cow. Considerable information concerning these values was obtained in a study of some 2600 pairs of successive lactation records, both milk and butterfat, from 99 different herds representing 6 breeds, in Iowa Cow Testing Associations.

Repeatability of successive records as determined by correlations and analysis of variance was used as the measure of value. Gross correlations between successive records increased at monthly intervals during the lactation, increasing more rapidly during the first four months, until a magnitude of approximately 0.80 and 0.67 was reached by the milk and butterfat records respectively, at the end of the lactation. The repeatability of lactation records two, three, and four months in length were relatively high.

When the variance affecting the repeatability was partitioned, breed differences accounted for the difference in magnitude of correlations observed between milk and butterfat records for the same lactations. Within breeds, differences between herds and intra-herd cow differences contributed about equally to the repeatability of records. There was some tendency for the herd effects to account for a larger fraction of the repeatability during the later months of the lactation.

REPORT OF DAIRY CATTLE BREEDING COMMITTEE

C. A. HUTTON, University of Tennessee

The Dairy Cattle Breeding Committee of the American Dairy Science Association met in New York City, January 20, 1943. Four members of the committee, and Dr. J. F. Kendrick of the Bureau of Dairy Industry, attended. The committee met primarily to consider the question of using Breed Association Herd Test records in the D.H.I.A. Proved Sire Program.

[1] The study from which this report is made was carried on at Iowa State College under the guidance of Dr. Jay L. Lush.

The question was raised by the Ayrshire Breeders' Association and the American Jersey Cattle Club, since these two associations were using D.H.I.A. records in their breed association herd improvement programs. After carefully reviewing and discussing the question the committee adopted the following statement and recommendation:

"In April, 1942, the Purebred Dairy Cattle Association adopted a Uniform or Standard Sire Proving Program consistent with the D.H.I.A. Sire Proving Program as it is implemented through the Extension Service of the State Colleges, Bureau of Dairy Industry, and the dairy herd-improvement associations. In order to increase greatly the number of proved sires and to increase the amount of data in proving them we recommend the reciprocal use of Herd Improvement Registry records and D.H.I.A. records in the Proved-Sire Programs of the Breed Associations and dairy herd-improvement associations."

Details of the plan for the exchange of H.I.R. and D.H.I.A. records were discussed in regard to record forms and details of setting up the exchange of records.

By invitation the committee attended the meeting of the Purebred Dairy Cattle Association in New York, January 21 and 22. Dr. Kendrick presented our recommendations relative to the reciprocal use of H I R and D H I A records in the sire proving program. The plan was favorably received and approved by unanimous vote.

We are glad to report that the Ayrshire Breeders' Association and the Brown Swiss Association have put into operation the reciprocal use of records, and the question is under consideration by the other national breed associations.

PRODUCTION SECTION

SYMPOSIUM PAPERS

1. Supply, Needs and Recommendations for Meeting Mineral and Vitamin Requirements of Dairy Cows under Present Conditions.
C. F. HUFFMAN, Michigan State College.

The critical livestock feed situation demands a careful re-evaluation of present livestock feeding practices in order to meet the food goals. Fortunately, the rations fed to dairy cattle in the United States supply most of the vitamins and minerals required for growth, reproduction and milk production. Occasionally the mineral elements iodine, cobalt and phosphorus, and vitamin A and certain members of the B-complex are needed as supplements.

The supplies of vitamin A, iodine and cobalt are adequate to meet present needs. There is a shortage of dried whey and feeding yeast which are used to supply the vitamin B-complex in calf starters.

The shift in poultry and swine feeding to more soybean oil meal in place of animal proteins has increased the need of phosphorus supplements. Consequently, there is a shortage of bone meal for dairy cattle feeding. The annual production of bone meal is about 100,000 tons. About 12,000 tons of defluorinated phosphate is available this year, with prospects of a much greater supply in 1944. The value of the phosphorus in this product has not been determined for dairy cattle.

The available supply of bone meal furnishes less than five per cent of the total phosphorus used by livestock in the United States. Roughages, cereal grains, wheat mill feed by products and protein concentrates furnish most of the phosphorus consumed by farm animals.

The phosphorus requirement of the dairy cow is met by allowing 10 gm. per 1000 pounds of body weight and 0.75 gm. per pound of milk above maintenance. When a roughage containing 0.18 per cent phosphorus is fed liberally along with a grain mixture containing 0.28 per cent phosphorus, a mineral supplement supplying this element is not needed. When the roughage contains as little as 0.12 per cent phosphorus, a grain mixture containing 0.5 per cent phosphorus meets the requirement. Since most hays and pastures contain more than 0.12 per cent phosphorus, the general use of a phosphorus supplement in the ration of dairy cattle does not appear logical at the present time. The bone meal should be conserved in order to supply phosphorus to areas where it is needed.

Recommendations

1. Feed phosphorus supplements to cows on pasture alone or pasture with cereal grains.

2. Feed phosphorus supplements to cows that receive legume roughages as the principal source of protein along with cereal grains.

3. A phosphorus supplement is not needed when a reasonable amount of a high phosphorus protein concentrate or a wheat mill feed is fed. A pound of wheat bran or cottonseed meal furnishes as much phosphorus as 1.5 ounces of bone meal.

4. Limit the use of a phosphorus supplement in commercial grain mixtures to those containing less than 0.5 per cent phosphorus.

5. Make phosphorous supplements available to the regions which need it.

6. Experiment stations should secure more data on the quantity of phosphorus in various roughages.

2. Methods Available for Measuring Transmitting Ability in Sires and Cows. JAY L. LUSH AND R. H. NELSON, Iowa State College.

The performance of ancestors and collateral relatives is the first available basis for estimating transmitting ability. But no amount of study can assure such estimates a high level of accuracy. They are worth some attention as rough guides but can easily be overvalued. Many of the bull calves and some of the heifers with the poorest ancestors and poorest collateral relatives will never be used for breeding. Since these are not present when animals with progeny are being compared, the range in pedigree merit among such animals is somewhat less than it would be in a totally unselected group. This reduces still more the actual usefulness of pedigree in contributing to estimates of transmitting ability when progeny tests are available.

All progeny tests are based primarily on the average performance of the offspring, but that *always* needs to be interpreted with reference to the kind of conditions under which the records were made and *may* need to be corrected for differences in the merit of the other parents. The various measures proposed differ chiefly in the use they make of the average production of the other parents of those offspring. More use should be made of information about the average production of contemporaries in the herd where those offspring made their records.

Random errors can be diminished by increasing the number of daughters. Biased errors cannot be thus reduced. In most data the biased errors will be large enough that the random errors are already reduced to secondary importance by the time there are as many as five daughters. Further increases in the number of daughters raises the accuracy of the estimate of transmitting ability only a little unless those biased errors are reduced by other methods.

The records used and the daughters tested should be unselected. Provided that is done, the four principal sources of biased errors are: (1) The general environment under which each group of daughters made their records may vary from sire to sire. (2) The general environment of the

daughters of a sire may not have been the same as the general environment of his mates. (3) The average genetic merit of the mates may vary from sire to sire. (4) Selection of the mates may have been more intense for some sires than for others, thus making the average record of the mates farther above their average transmitting ability in some cases than in others.

The most widely used measures of transmitting ability are: A. The average of the daughters. B. The increase of daughters over dams. C. The sum of A and B, known under various terms such as the intermediate, equal-parent, modified Mount Hope, Yapp-Hansson, etc., indexes. B is sometimes expressed as a percentage and A may be expressed (cf. Lamaster's production factors) as a percentage of some group such as the average of all cows of that age class in the breed.

These measures are affected as follows by the biased errors. A is affected most and B least by (1). B is affected most and A not at all by (2). A and B are affected in opposite directions by (3) while C is unaffected. B is affected most by (4) while A is not affected.

C is believed to be more widely useful than the other two but, since the measures are not equally vulnerable to all kinds of errors, there may be some sets of data in which A or B would be more accurate. For example, if there are data in which it is known that (2), (3), and (4) were very small or zero, while (1) was large, B would be more accurate there. Or in data in which (1) is known to be unimportantly small but (2), (3), and (4) are serious, A will be more accurate. Our own analyses lead us to think that (1) is generally the most serious source of error although (2) certainly will be in some cases. (4) can only rarely be of major importance since opportunity to vary widely the intensity of selection of mates will not often occur.

Where some or all of the dams are untested, B or C can be used to good advantage by using in place of the missing records the average production of the contemporaries of the daughters in the same herd. This helps correct for errors (1) and (2).

The uniformity of the progeny is of little if any use in measuring transmitting ability, since such uniformity is only very slightly repeatable and seems to be even less transmissible.

Since a cow can have only a few tested daughters, her own records will be the main basis for estimating her transmitting ability. The records of her daughters are a useful supplement to this but do not take first place.

Averaging all of a cow's records instead of using just one helps to minimize random environmental errors (which are the largest source of error in single records) although it does not help in overcoming errors caused by dominance or epistasis or by general environmental differences from one herd to another.

3. Proving Sires and Brood Cows Under Field Conditions and the Part Artificial Insemination Can Play in the Program. S. J. BROWNELL, Cornell University.

The most difficult problem in proving sires under field conditions is to properly evaluate those environmental conditions that tend to influence the true picture of their genetic makeup. The conditions briefly discussed that enter into this situation are, feeding, seasonal variations as they influence the production of quality and quantity of roughages and grains, price relationships, and the genetic makeup of the mates of the bulls. Cooperators in the dairy cattle extension breeding program are enrolled to demonstrate these influences. The Animal Husbandry Extension Service then makes a complete analysis of several years of record keeping on the herd. Outstanding analyzed sires and cow families are discovered in the herds of these cooperators through the analysis of their demonstrations. Further check on the interpretation of the genetic makeup of a bull is then made by the use of the outstanding sires in the state program of artificial insemination, where the usefulness of these sires is increased manifold. In this way a more accurate measure can be made of the reliability of the method used in measuring the genetic makeup of a bull. These methods can be further checked through the selection of young bulls sired by the outstanding analyzed sires and out of foundation cows in the more desirable cow families. This service is also extended through the extension use of "The Guide to Superior Dairy Inheritance."

4. International Post-War Cooperation in Dairy Cattle Breeding. E. J. PERRY, Rutgers University.

After the war the burden of rehabilitation resting upon the stronger nations will be tremendous. Food and feed and extra livestock will have to be supplied quickly and then will follow the program to help the liberated people and other needy nations to help themselves. The United Nations Food Conference advices that the world milk supply should be increased 80 per cent.

An International Dairy Cattle Association or World Cattle Breeding Society could be made to serve a very useful purpose both immediately after the war and long into the future. Composed of accredited representatives of cooperating countries it could: (1) Aid in the task of rehabilitation by such steps as (a) direct cattle shipments and (b) shipment of sperm of superior bulls by air transportation. (2) Foster reciprocity among countries in the improvement of breeds and herds by shipment of sperm and by trade in breeding stock where adaptation and disease control are not problems. (3) Work toward the practice of uniformity in proving bulls, conducting cooperative breeding associations, etc. (4) Aid in the prompt exchange of results of research in breeding.

RESEARCH PAPERS

P1. Influence of Quality of Protein in the Concentrate Mixture on the Milk Production of Cows Fed Mixed Hay and Corn Silage as Roughages. R. W. BRATTON, G. W. SALISBURY, AND F. B. MORRISON, Cornell University, Ithaca, N. Y.

During the past several years an extensive series of metabolism experiments with growing lambs has been conducted at Cornell University to determine whether or not the quality of protein in the ration was of importance for them. For these growing lambs there has been no difference in the efficiency of the "high quality" protein furnished by dried skim milk, casein, or soybean oil meal and protein that would be of lower quality for non-ruminants, furnished by corn gluten meal or linseed oil meal. These experiments have been conducted by J. I. Miller and F. B. Morrison, and earlier experiments by K. L. Turk and F. B. Morrison.

In addition to the metabolism experiments with lambs, the Animal Husbandry Department has conducted practical feeding experiments with dairy cows, with fattening steers, and with fattening lambs to determine whether the quality of protein in the concentrate mixture or grain mixture, was of any importance for these classes of stock when there was little or no legume forage in the ration.

Five experiments with dairy cows have been completed in each of which one group of cows was fed a simple grain mixture consisting of ground corn, ground oats, corn gluten feed, and corn gluten meal, which would supply poor-quality protein for non-ruminants. Another group was fed a mixture supplying better protein and more variety. This contained not only ground corn, ground oats, and corn gluten feed, but also soybean oil meal, linseed meal, cottonseed meal, and corn distillers' dried grains. In the last two trials 5 per cent of cane molasses were included in each mixture. For roughage the cows had corn silage and mixed hay low in legumes.

On the average, the cows fed the higher-quality-protein grain mixture produced 36.93 pounds of 4 per cent fat-corrected milk a day, in comparison with 36.55 pounds for the other ration. This small difference of only 0.38 pounds of milk was not significant. In two of the experiments, the yield was higher on the low-quality-protein mixture, in two experiments it was higher on the high-quality-protein mixture, and in the other trial there was no difference. There were also no significant differences in the health or the maintenance of liveweight on the two rations.

These experiments with a total of 86 lactations, show clearly that the kind or quality protein is of little practical importance in any ordinary grain mixture for dairy cows, even when but little of the roughage is legume forage. This means that, in making up a grain mixture for dairy cows, one can use whatever protein supplements are available, so long as the mixture

is palatable to the cows and made up of satisfactory feeds for milk production.

This fact is of especial importance at the present time when there is a serious shortage of protein supplements supplying protein of high quality, and the high quality protein is urgently needed for the feeding of swine and poultry.

P2. Some Factors Affecting Biological Values of Proteins for Growing Dairy Heifers.* ERIC W. SWANSON, H. A. HERMAN, AND A. C. RAGSDALE, University of Missouri, Columbia.

Biological values of proteins for dairy heifers were found to depend primarily upon the nutritive ratio of the ration and to be poor indexes of the nutritive value of the feed protein. Average biological values of various proteins determined with eight heifers ranged from 67 for milk proteins to 86 for lespedeza hay proteins when each ration was adjusted to approximately 10 per cent protein by addition of carbohydrates. Early and late-cut lespedeza hay alone (about 11.5 per cent protein in each) gave biological value of 67 and 46, respectively.

With the exception of the late-cut lespedeza protein which was poorly utilized because of the low total digestible nutrient supply of the hay, the various biological values did not indicate differences in net utilization of the proteins. The actual amounts of nitrogen utilized from the various rations furnishing equivalent amounts of total digestible nutrients were practically the same. The digestibility of the vairous proteins was quite variable, however. The average digestion coefficient of the milk proteins was 56.8, that of the lespedeza hay proteins 42.3. Because of this relatively constant amount of nitrogen utilized and variable amount digested, the higher the digestibility of the protein the lower was its biological value; also, the higher the percentage of protein fed the lower was its biological value.

Determinations of the total digestible nutrients supplied by 16 different rations showed a definite positive correlation ($r = 0.88$) between the biological values and the nutritive ratios of this wide variety of rations. Proteins which gave widely different biological values when fed at the same concentration in the ration gave nearly identical biological values when fed at the same nutritive ratio (*e.g.*, the milk and early-cut lespedeza hay cited above). Biological values were about 45 at a nutritive ratio of 1:4, about 65 at 1:9, and about 85 at a nutritive ratio of 1:14. The expected relationship between nitrogen utilization and nutritive ratio was disturbed, however, when the rations did not furnish enough total digestible nutrients (*e.g.*, the late-cut lespedeza hay). This indicated the preferential use of protein for energy rather than growth when the feed intake was inadequate.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 903.

From the similar utilization of different feed proteins when they are digested in similar nutritive ratios it appears that the differences among feed proteins often shown with rats are of little importance in ruminant nutrition. The recognized capacity of the rumen microorganisms to grow abundantly and synthesize new compounds from the feed is a probable explanation of the relatively indifferent effect of feed protein composition upon its net utilization by dairy heifers.

P3. Urea as a Protein Substitute in War Time. I. W. RUPEL, G. BOHSTEDT, AND E. B. HART, University of Wisconsin.

There is a shortage of 1,101,000 tons in protein feeds commonly used for dairy cattle, based upon estimated needs to meet production goals for the current year. If this shortage were borne by the dairy cattle, beef cattle and sheep, to the exclusion of hogs and poultry, it represents 22 per cent of the supply needed.

It has been shown that dairy cattle can utilize urea nitrogen for growth and milk production. Fifteen lactations completed on a basal ration of timothy hay, corn silage, with corn and oats as a concentrate, averaged 6675 pounds of 4 per cent fat-corrected milk. The same cows fed the basal ration plus 3 per cent urea in the concentrate averaged to produce 7690 pounds of 4 per cent milk. When 34 pounds of linseed meal replaced as much corn and oats in each 100 pounds of the concentrates, 15 lactations averaged 7790 pounds of 4 per cent milk.

No toxicity was experienced when the urea ration was fed. Quality of product obtained, maintenance of body weight and reproduction on the urea ration were normal.

The nitrogen deficit represented by the 1,101,000 ton shortage of protein feeds can be supplied in 128,000 tons of 42 per cent grade urea.

In dairy sections, where hay, silage and home grown grains are available, a suitable nitrogen level in the concentrate mixture can be secured by the inclusion of 3.3 pounds of urea (42 per cent grade) in 100 pounds of the grain mixture. Full value from urea may be obtained only when the total protein equivalent intake (based on total N) is not in excess of feeding standard requirements.

Computations of replacement values show urea (42 per cent grade) to be worth $113.00 per ton when other feeds are priced per ton as follows: linseed meal $45.00, corn and oats $35.00, timothy hay $15.00, and corn silage $5.00.

P4. Balance Studies on Milking Cows Fed Molasses Grass Silages and Phosphoric Acid Grass Silages. W. A. KING, N. J. Agr. Expt. Sta.

Twelve 14-day balance studies of nitrogen, calcium and phosphorus on milking cows have been completed. Groups of three cows each were used in

the trials. Two types of silages were studied, namely, molasses alfalfa and phosphoric acid alfalfa silages, and molasses oat and phosphoric acid oat silages. The alfalfa was ensiled with 87 pounds of molasses and with 24 and 12 pounds of 68 per cent phosphoric acid in three separate silos. The oats was ensiled with 60 pounds of molasses and with 20 pounds of phosphoric acid. The silages in the various trials were fed with hay and grain, with limestone in the case of part of the acid silage, and also without supplements. The concentrate fed with the alfalfa silages was a mixture of corn and oats, whereas that fed with the oat silages was supplemented with linseed meal, and in the case of the acid silage, two per cent limestone, and two per cent bone meal with that of the molasses oat silage.

In only three trials were negative nitrogen balances observed. These occurred when the phosphoric acid alfalfa and phosphoric acid oat silages were fed with limestone and when molasses oat silage was fed alone.

In three of four trials conducted with alfalfa preserved with 24 pounds of acid the cows were in negative calcium and phosphorus balance. When the acid oat silage was fed with limestone the cows showed a retention of calcium but a distinct loss of phosphorus. In the above cases the cows received six times more calcium and four times more phosphorus than their calculated requirements. The cows showed a retention of both calcium and phosphorus when the acid oat silage was fed with hay and grain (these last two feeds furnished 35 per cent of the total phosphorus intake). A retention of both calcium and phosphorus was observed when phosphoric acid alfalfa silage (12 pounds of acid) was fed. In contrast the groups of cows fed the molasses preserved silages showed retention of both calcium and phosphorus with only a few exceptions.

It seems that the phosphorus of the phosphoric acid silages is not too readily available. Retention of phosphorus was noted only when the requirement was low, when the amount of acid used was low, or when high-phosphorus supplements were fed.

P5. Chemical Analysis and Silage Quality. A. E. PERKINS, Ohio Agricultural Experiment Station.

The conventional feeding stuff analysis gives a reasonably accurate basis for comparing the potential value of a silage with similar data regarding other feeds. Such an analysis reveals nothing, however, regarding that aspect of quality which determines whether this silage will be eagerly eaten or entirely refused by animals. Of two silages showing identical analyses, one might be of excellent feeding quality and the other practically worthless on this basis.

Human sensory judgment of silage quality varies with the individual, and descriptive terms are poorly defined and difficult to duplicate and compare.

Palatability trials with animals are the court of final resort regarding silage quality but vary in result with the nutritional status and previous feeding habits of the animals used, as well as with the kind and amount of supplementary feeding and the procedure followed. Feeding trials involve much labor, and the results are difficult to duplicate or compare.

Chemical analyses have the great advantage over the other measures of quality that they are readily reproducible and can conveniently be recorded and compared on an exact numerical basis.

(1) In many reports of silage studies in recent years pH is the only determination given other than the feeding stuff analysis. Although pH is a valuable determination, it does not by itself furnish a complete or satisfactory basis for judging silage quality.

(2) Ammonia determinations are reported by a few workers. Ammonia seems to have a rather close negative correlation with silage quality. Probably the failure to use it more generally is due largely to the extra work involved.

(3) Titratable acidity seems to have been dropped from the list of determinations usually reported in favor of pH. Titratable acidity does not by any means parallel the pH determination and is well worth running in addition to pH.

(4) Amino nitrogen by the Sorensen method runs parallel to the ammonia determination at a higher level on most silages. Ordinarily it includes the ammonia. It is much more quickly determined than ammonia and can be used as a substitute determination.

(5) Mention is frequently made of butyric acid but in view of the difficulties involved in this determination the assumption seems warranted that many such reports are based on smell rather than chemical analysis.

Determinations (1), (3), and (4) are thought to provide jointly a much better basis for judging silage quality than any single determination. All three of these determinations can be carried out in about 10 minutes on the same sample, once the juice or water extract of the silage is prepared.

P6. The Fermentation in Legume Silage with Wilting and with Corn and Cob Meal as a Preservative. R. W. Stone, F. R. Murdock, and S. I. Bechdel, The Pennsylvania State College.

A series of alfalfa silages was put in nine small silos each holding about seven tons of chopped fodder, in order to determine the effect of wilting and the addition of dry hay, corn, stover, ground corn, and salt on preservation. Bacterial and chemical analyses were made on the original plant material and at intervals during three months storage.

During the first week of fermentation, all silages were subject to the development of typical lactic acid bacteria, genus *Lactobacillus*, irrespective of the treatment used. Likewise, all silages developed an initial concen-

tration of at least 1.5 per cent lactic acid. In the control silage with no treatment, as soon as the reducing sugar was nearly exhausted, acetic acid was formed by these organisms at the expense of the lactic acid. This change was accompanied by a rise in pH and decrease in quality. Lowering the moisture approximately five per cent by adding dry hay and corn stover slowed the rate of spoilage but did not result in a high quality product. Similarly the addition of 15 pounds of salt per ton did not insure the maintenance of the lactic acid. Ground corn and cob meal at the rate of 200 pounds per ton of alfalfa gave a product equal in quality to preservation by 80 pounds of molasses. Wilting the cut alfalfa for 2 to 3 hours in the sun before raking produced a good silage. It is noteworthy that the wilted alfalfa contained a higher level of reducing sugar than the fresh material. All of the silages that were of good quality continued to develop lactic acid until at least two per cent or more was present. It is apparent that an adequate supply of fermentable carbohydrate is a prime requisite for making good alfalfa silage.

P7. Citrus Molasses—A New Feed. R. B. Becker, P. T. Dix Arnold, George K. Davis, and E. L. Fouts, Florida Agricultural Experiment Station.

Citrus molasses, a by-product of citrus pulp, first was manufactured commercially in Florida in 1941–42. It results when the press juice from fresh pulp is evaporated to about 13-to-1 concentration. This molasses is a yellowship sirup having 61 to 63 per cent of nitrogen-free extract, about two-thirds of the sugars being other than sucrose; 3.8 to 4.0 per cent crude protein; about 5 per cent of mineral matter, part of which may be a calcium citrate precipitate in suspension; a pH of about 4.6, and weighing 11.5 pounds per gallon.

Citrus molasses has a characteristic lingering bitter flavor due to concentration of naringin from the peel. This molasses was palatable to dairy cows when offered as 5 and 10 per cent of mixed concentrates. Fed to dairy cows 2 hours before milking, no intense or off-type feed flavor was noted in their milk. If offered at milking time, no effect on milk flavor would be expected.

When added to cut Napier grass 2, 4, and 0 per cent levels, the resulting silages were preferred by Jersey cattle in the order named. Pigeon pea forage ensiled satisfactorily with 4 per cent of citrus molasses.

P8. Value of Prairie Hay for Milk Production. A. H. Kuhlman, Oklahoma Agricultural and Mechanical College.

Preliminary estimates of the United States Department of Agriculture indicate that 584,000 tons of prairie hay were produced in Oklahoma in 1942. Since many dairy farmers throughout the southwest feed considerable quantities of prairie hay, information concerning the value of prairie

hay in dairy rations should be of interest at this time when the government is urging an increase in milk production.

Four, 90-day, double reversal feeding trials, including a total of 47 cows, have been completed at the Oklahoma Experiment Station comparing an alfalfa hay ration and a prairie hay ration. The alfalfa hay ration consisted of U. S. No. 1 alfalfa hay and a concentrate mixture composed of four parts by weight ground corn, two parts ground oats, two parts wheat bran, and one part cottonseed meal (43 per cent protein), and contained 15.0 per cent total protein and 12.0 per cent digestible protein.

Prairie hay contains less protein than alfalfa hay. To provide sufficient protein it was necessary to increase the amount of cottonseed meal in the concentrate mixture fed with the prairie hay. This mixture consisted of four parts by weight ground corn, two parts ground oats, two parts wheat bran and three parts cottonseed meal and contained 20.0 per cent total protein and 16.2 per cent digestible protein. The prairie hay used each year was of good quality and would grade U. S. No. 1 extra green.

In each ration the hay was fed each cow at the rate of two pounds of hay daily for each 100 pounds of body weight. The concentrate mixtures were fed according to the yield and fat test of the milk produced by each cow.

The average daily milk yield per cow in the four experiments was 26.4 pounds of 4 per cent fat-corrected milk on the alfalfa hay ration and 25.8 pounds on the prairie hay ration. For each 100 pounds of 4 per cent milk produced on the check ration, 40.3 pounds of concentrates and 70.8 pounds of alfalfa hay were consumed and 72.4 pounds of alfalfa hay were offered. For the same amount of milk produced on the experimental ration the cows consumed 41.7 pounds of concentrates and 70.1 pounds of prairie hay and were offered 75.3 pounds of the hay.

On the basis of the results obtained and using current feed prices, if alfalfa hay costs $15.00 per ton and cottonseed meal $48.00, the prairie hay, as used in this experiment was actually worth from 76 to 94 per cent as much as alfalfa hay. On the average, the prairie hay used in the four experiments was worth 87 per cent as much as the alfalfa hay.

The results emphasize the importance of good management of native meadows to keep them free from weeds, and of proper care in harvesting and curing the crops produced on them. When legume hay is not available, satisfactory milk production can still be obtained if good prairie hay is fed with a concentrate mixture which will supply the required amount of protein.

P9. Alyce Clover Hay vs. Lespedeza Hay for Milking Cows. D. M. SEATH, CECIL BRANTON, AND L. L. RUSOFF, Louisiana State University.

A double reversal trial was conducted comparing hay from alyce clover (*Alysicarpus vaginalis*) a new forage, and common lespedeza (*Lespedeza*

striata). The alyce hay graded approximately U. S. No. 1 and the lespedeza hay approximately U. S. No. 2. Unfortunately, lespedeza hay of better quality was not available.

The test was conducted for three 21-day periods with two groups of ten cows each. The cows were fed hay "ad libitum" and in addition received corn silage at the rate of three pounds for each 100 pounds of liveweight and concentrates at the rate of nine pounds for each pound of butterfat produced.

Hay consumption averaged approximately 18 pounds per cow per day for alyce and 16 pounds for lespedeza. Milk and butterfat yields favored the alyce hay by 1.4 pounds of milk per cow daily (5.3 per cent) and by 0.09 pounds of butterfat (9.7 per cent). It is believed that grade differences between the two hays were responsible for the production differences obtained. In view of the results it is predicted that alyce clover will play an ever-increasing role as a hay crop in the Gulf States region of the South.

P10. Protein Supplements for Dairy Calves. THOR. W. GULLICKSON AND RAYMOND L. HANSON, University of Minnesota.

Feeding trials were conducted for the purpose of comparing the value of linseed meal, cottonseed meal, corn gluten meal, soybean oil meal and ground soybeans as protein supplements in the rations of young dairy calves. Five lots of calves of mixed breeding were used. All lots were fed alike except for the protein-rich feed included in the grain mixture. The high protein concentrate in each case constituted 50 per cent by weight of the grain mixture.

The calves were started on experiment when about seven days old and continued on the ration until they were 120 days of age. Records were kept of weights, physical condition, and general appearance of animals.

Indigestion or scouring occurred in one or both calves in several lots but was most pronounced in those fed linseed meal and ground soybeans. None of the calves receiving cottonseed meal in their ration suffered from indigestion, neither were there any other harmful effects from feeding this product.

The average daily gain in weight of the calves in the various lots ranged from 1.31 pounds by the calves receiving ground soybeans to 1.03 pounds for the lot fed corn gluten meal. The daily gains of the other lots were as follows: cottonseed meal 1.30 pounds, linseed meal 1.13 pounds and soybean oil meal 1.18 pounds. The calf making the highest average daily gain of 1.55 pounds was fed ground soybeans and the lowest, 0.92 pound, was made by one of the animals receiving corn gluten meal.

The lowest amount of nutrients, beyond the quantity needed for maintenance, per pound of gain in weight, was required by the lot of calves receiving ground soybeans, being 0.93 pound. Next in order was the lots fed corn gluten meal, cottonseed meal, soybean oil meal and linseed meal

with requirements of 0.94, 1.07, 1.12 and 1.14 pounds total digestible nutrients each, respectively.

The data indicates that there probably is little or no difference in feeding value for young calves between ground soybeans, soybean oil meal, cottonseed meal and linseed meal. Corn gluten meal may also be fed with safety, but when forming as much as half of the grain mixture lowers its palatability.

P11. Mineral Studies of Louisiana Dairy Cows. I. The Hemoglobin, Calcium and Phosphorus Analyses of Blood. L. L. RUSOFF AND D. M. SEATH, Louisiana State University, Baton Rouge.

The first phase of a survey of the blood of 186 dairy cows representing 15 herds in the milk shed area (Tangipahoa Parish) for New Orleans showed the hemoglobin to be normal, serum calcium to range from 7.3 to 12.8 mg. per cent, and serum inorganic phosphorus from 3.0 to 11.9 mg. per cent. Significant herd differences were found with calcium ranging from 8.7 to 11.9 mg., the average being 10.45 mg. per cent, and phosphorus from 3.5 to 9.1 mg. with an average of 6.2 mg. per cent.

It is known that the soils of this region are deficient in calcium and phosphorus. Cattle in most of the herds were fed liberal amounts of concentrates that contained a high percentage of cottonseed meal. Only small amounts of roughage were fed during the winter months and this was of low quality.

P12. A Study of Poikilocytosis in Dairy Cattle (A Preliminary Report). J. T. REID, C. F. HUFFMAN, AND C. W. DUNCAN, Michigan State College.

Poikilocytosis is a pathological condition of the blood characterized by abnormally shaped red blood corpuscles. During this investigation involving 423 dairy animals of varying ages, 233 of the animals studied were affected with poikilocytosis.

The red blood cell count, red blood cell volume and hemoglobin content were determined. The shape of the red cells was studied by the use of blood smears and hanging drop preparations in which the corpuscles were suspended in physiological saline or plasma as a suspension medium. Precaution was observed to avoid the production of artifacts, such as those caused by crenation and traumatic injury.

The occurrence of the condition was distributed among the affected animals as follows: 81 animals showed one to 10 per cent; 31 showed 11 to 20 per cent; 21 showed 21 to 30 per cent; 13 showed 31 to 40 per cent; 19 showed 41 to 50 per cent; 15 showed 51 to 60 per cent; 9 showed 61 to 70 per cent; 12 showed 71 to 80 per cent; 18 showed 81 to 90 per cent; and 14 animals showed 91 per cent or more of their red corpuscles as poikilocytes.

Usually the animals that manifested 50 per cent or more poikilocytes in their blood showed subnormal health. The outstanding symptom observed in the more severely affected animals was anorexia. Depraved appetite was manifested occasionally. Emaciation, general roughness and unthriftiness were other noticeable symptoms.

Poikilocytosis occurred independent of hemoglobin, red blood cell volume and red blood cell count.

Some of the animals affected with poikilocytosis responded to cobalt administration while others did not show any improvement. The feeding of a mineral mixture furnishing 250 mg. Fe, 250 mg. Mn, 25 mg. Cu and 5 mg. of Co per calf per day failed to correct the poikilocytic condition in several animals although the hemoglobin content of the blood was increased. A limited number of animals treated with live yeast, Brewers yeast or pyridoxine showed a remarkable amelioration of the poikilocytic condition after three to four weeks treatment.

P13. Cobalt Studies with Dairy Cattle in Michigan. C. W. DUNCAN, C. F. HUFFMAN, J. T. REID, AND B. J. KILLHAM, Mich. Agr. Exp. Sta., East Lansing.

Field and laboratory studies have been conducted during the past three years on a nutritional deficiency disease of dairy cattle occurring during the late winter and early spring months which is characterized by a gradual loss of appetite for good hay and cereal grains. Many of the mature animals developed a morbid appetite and became emaciated and died. Both young and mature animals of both sexes were affected. Many deaths have been recorded on some farms but only occasional losses have occurred on other farms. In some sections of the state the calf losses have become of economic importance. An extreme variability of the incidence of this condition under apparently identical conditions was found from farm to farm and among cattle on the same farm. All cases of extreme anemia, including the borderline cases, have had the symptoms completely alleviated and optimal response in the appetite of all of the animals occurred within one week by the administration of 5–15 mg. of cobalt per day. The only change that was made in the routine feeding practice on all of the farms was the addition of a cobalt supplement.

The chief biochemical findings have been a marked reduction of hemoglobin in the blood of the severely affected animals and a slow response in hemoglobin regeneration even after a pronounced improvement in general condition was apparent. The slow response in hemoglobin regeneration may have been due to a rapid increase in blood volume resulting from a large increase in feed and water consumption. The hemoglobin level improved gradually after the continued feeding of cobalt but no high values were obtained which might indicate polycythemia.

The lack of condition and the low hemoglobin values found in the dairy cattle have been associated with a low concentration of cobalt in the home-grown hay and grains. The amount of cobalt found in the hay on the affected farms is approximately 50 per cent lower than that grown on unaffected farms.

P14. The Effect of Parturition and Beginning Lactation on the Level of Carotene and Vitamin A in the Blood Plasma of Dairy Cows. T. S. SUTTON AND P. A. SOLDNER, Ohio Agr. Expt. Sta. and Ohio State Univ.

In a study of the level of carotene and vitamin A in the blood plasma of dairy cows involving routine determinations at four week intervals occasional extremely low values were observed. A check of the records showed that these low valhes were obtained from cows that had recently dropped calves. Following this observation the effects of parturition and beginning lactation on the plasma level of vitamin A and its precursor was studied in greater detail. Eighteen cows representing three breeds were studied: 8 Ayrshires; 6 Guernseys; and 4 Holsteins. The investigation was carried out during the winter feeding period. Blood plasma vitamin A and carotene values were maintained at normal levels of about 16 micrograms per cent and 400 micrograms per cent respectively until approximately one week prior to parturition. At the time the mammary gland begins to fill there is a precipitous drop. The average level for carotene within three days of parturition was 235 micrograms per cent and for vitamin A the average was 8.2 micrograms per cent. Samples taken within three days post-freshening gave average values of 220 and 7.5 micrograms per cent for carotene and vitamin A respectively. Following this there was a gradual rise, however levels had not completely returned to normal four weeks following parturition.

P15. Carotene Requirements for the Maintenance of a Normal Spinal Fluid Pressure in Dairy Calves. L. A. MOORE AND M. H. BERRY,* University of Maryland, AND J. F. SYKES, Michigan State College.

Previous papers have shown that an increased pressure of the spinal fluid developed in calves in vitamin A deficiency. It was thought, therefore, that periodic measurement of this pressure might be used as a criterion for the adequacy or inadequacy of various intakes of carotene.

Measurements of the spinal fluid pressure was found to be a fairly delicate criterion of adequacy since small differences of intake could be differentiated. It was possible to distinguish between intakes of 62 and 66 micrograms of carotene per kilo of body weight per day. Because of individual

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characteristics, blood plasma vitamin A and carotene values did not distinguish between variations of intake of 62 to 75 micrograms per kg. of body weight. An intake of 66 micrograms of carotene per kilo of body weight per day during the winter months was found to be about the minimum required to prevent an elevation of the pressure of the spinal fluid in Holstein and Ayrshire calves. Plasma ascorbic acid values showed no relationship to increased spinal fluid pressure.

P16. The Effect of Additional Vitamins A and D in a Standard Calf Starter. E. A. KEYES, S. I. BECHDEL, AND W. T. S. THORP, The Pennsylvania State College.

This investigation was started early in 1942. The experimental calves consisted of 36 grade and purebred Holstein calves which were divided into four groups of 9 calves each.

Group I was fed a standard calf starter which was used as the basal ration. Group II was fed the basal ration plus enough vitamin D supplement to insure approximately 2000 I.U. per 100 pounds of live weight per day from birth until the daily consumption of calf starter had reached 2 pounds. Group III was fed the basal ration plus enough vitamin A supplement to insure at least 30 micrograms of carotene or equivalent per pound of live weight per day from birth until the daily consumption of calf starter had reached 2 pounds. Group IV was fed additional vitamins A and D as provided in Groups II and III.

Six calves from each group were slaughtered at 16 weeks of age. Three calves were continued for one year at which time one animal from each group was slaughtered. Tissues were saved from the internal organs of all animals slaughtered. A histopathological study is being made of this material.

The calves were fed a total of 350 pounds of whole milk in the experimental period and all were fed the same kind of timothy-clover mixed hay. All calves were handled under the same environmental conditions.

The end of the 16 week period showed Group II to have gained 7.1 pounds, Group III 12.7 pounds, and Group IV 6.5 pounds more per calf than Group I, the basal group. In addition to the greater weight, a superior appearance was also shown by a more sleek coat of hair, especially in Groups III and IV, and greater skeletal growth. The Group I calves were the poorest of all groups. In general, the x-ray pictures, blood carotene, calcium and phosphorus determinations confirmed the physical findings.

The end of the 52-week period showed Group IV to have gained 17.4 pounds, Group III 15.8 pounds, and Group II 15.7 pounds more per calf than Group I. The calves in Group III showed the best coat of hair but in skeletal growth Groups II, III, and IV were about equal and were better in all respects than Group I.

In general, the results indicate that a more liberal supply of vitamins A and D for calf starters is advantageous in producing strong, healthy calves.

P17. Changes in Carotene Content of Prairie Hay During Storage.
A. H. KUHLMAN AND W. D. GALLUP, Oklahoma A. and M. College.

Since April 1938 carotene determinations have been made of monthly composite samples of prairie hay used in a study of the carotene requirements of Jerseys for reproduction and lactation. Daily at the time of feeding a small representative sample of the hay fed was placed in a covered metal container. At the end of each calendar month the composite sample was taken to the laboratory thoroughly mixed and ground and a representative portion of it was used for carotene determinations. Carotene values of 57 composite monthly samples are now available representing 13 separate lots of hay purchased from farmers in the vicinity of Stillwater. Most of the hay was U. S. no. 1, extra green. In general sufficient hay was purchased to last through a feeding period of from six to ten consecutive months, but several times smaller lots were purchased in June and July before a new hay crop was available.

While some prairie hay is harvested in Oklahoma during July, most of the crop is cut in August and September. Most of the hay is baled in the field.

Loss of carotene occurs during the time when cut green grass is exposed to sunlight. This loss continues even when properly cured hay is stored in barns or sheds. A general idea of these losses in prairie hay may be gained from the carotene values of the monthly composite samples collected during the past five years.

The average carotene content of 7 monthly composite samples of prairie hay fed during the months of July, August and September of the year in which the hay was harvested was 31.6 parts per million. Twelve monthly samples of hay fed during October, November and December averaged 28.2 parts per million. Sixteen samples of the hay fed during January, February and March averaged 24.8 parts per million. Fifteen samples representing the hay fed during April, May and June contained only 17.1 parts per million. The hay fed during the last three months of this period on the average had only 54% as much carotene as during the first three months.

Considerable variation, however, was found in the rate of changes in carotene values of the different lots of hay. Usually the carotene values would remain fairly constant for a period of 4 or 5 consecutive months before a marked loss occurred. In one case, this rapid loss began in December but it usually occurred after February. Of 35 monthly samples of hay fed from July to the end of the following March, 31 samples had carotene values of 20 or more parts of carotene per million, and only 4 had less than

20 parts. Of six samples for the month of April, 3 had more and 3 had less than 20 parts per million. All of the sixteen samples of the hay fed later than April had carotene values less than 20 parts per million.

P18. Summer Sunshine as a Source of Vitamin D for Dairy Cows. G. C. WALLIS, So. Dak. Agricultural Experiment Station.

Previously reported work from other stations implies that summer sunshine is largely responsible for building up the dairy cow's reserves of vitamin D and providing for the higher vitamin D potency of summer butterfat. In this experiment designed to give a more direct attack on this problem the cows failed to build up the expected reserves or to produce butterfat of the potency expected in summer butterfat.

Two grade Holstein cows were used. They were first depleted of vitamin D by placing them on a vitamin-D-deficient ration and keeping them out of direct sunshine. When evidence from the observations on (1) the physical condition of the animals, (2) the level of total calcium and inorganic phosphorus in the blood plasma, (3) the vitamin D in the blood plasma (4) the vitamin D in the butterfat, and (5) the results of mineral balance trials indicated that a vitamin D deficiency existed the cows were turned out into summer sunshine with no other change in the experimental ration or procedure.

The physical condition and the appetite of the animals was much improved within a couple of weeks after sunshine exposure. The calcium and inorganic phosphorus of the blood plasma soon returned to normal levels, and the calcium and phosphorus balances shifted from negative to strongly positive. While there was an unmistakable increase in the vitamin D content of the blood plasma and butterfat the concentrations were far below those ordinarily found in dairy cows under regular summer management. For example, the concentration of vitamin D ranged a little over 0.20 International Units per cc. of blood plasma and never got above 0.31 units in these cows whereas values of 5 or 6 International Units per cc. are not uncommon in cows under usual summer conditions. The butterfat never got above 0.20 International Unit of vitamin D per gram whereas summer butterfat from regular sources often runs to 0.75 to 1.00 Unit per gram. The concentration of vitamin D in the blood plasma and butterfat showed very little more increase after the first month even though sunshine exposure continued in favorable weather throughout the summer and during the following winter. By spring mild symptoms of a vitamin D deficiency were developing indicating that the accumulated reserves were insufficient to carry the cows through the winter.

Summer sunshine is an effective source of vitamin D for dairy cows but it alone failed to build up the blood plasma and butterfat to the levels found in cows under normal summer management. Further studies are necessary

before an adequate explanation of the source of vitamin D for building up summer reserves and enhancing the vitamin D value of summer butterfat can be given.

P19. Urinary Excretion of Ascorbic Acid in Dairy Cattle (A Preliminary Report).* J. W. COTTER AND L. A. MOORE, University of Maryland.

In view of previous reports indicating some relationship between vitamin A intake and blood plasma ascorbic acid, it was considered advisable to study the relation of vitamin A intake to urinary excretion of ascorbic acid.

In this preliminary report results are given for the total amount of ascorbic acid excreted in the reduced form in the urine during twenty-four hour collection periods for animals on a normal ration and animals fed on low levels of carotene intake.

The first group of animals consisted of eight heifers fed on normal rations. One of these heifers was open while the rest were in various stages of pregnancy. They varied in excretion from 27 to 136 mg. of ascorbic acid per day, and it appeared that pregnancy had no effect on the level of excretion. When two of the animals of this group were fed 5 gms. of chlorobutanol per day, the excretion ranged from 267 to 634 mg. of ascorbic acid.

A second group of three heifers on a restricted level of carotene intake was used. Two were pregnant and one was non-pregnant. The excretion of ascorbic acid from the pregnant animals ranged from 107 to 409 mg. per day. The feeding of 5 gms. of chlorobutanol to these animals did not cause a marked increase in the excretion of ascorbic acid. The non-pregnant animal excreted 98 mg. per day and after feeding chlorobutanol excreted up to 473 mg. per day.

A third group consisted of six yearling male animals. Four of these animals were receiving carotene at the rate of 44 to 75 micrograms per kilo of body weight, a low intake, while the other two were on normal rations. The amount of ascorbic acid excreted varied from 75 to 203 mg. with no particular relationship to carotene intake. But variations in the amounts of ascorbic acid excreted in the urine from day to day was observed in both groups. The four animals on a low carotene intake later were depleted of vitamin A for one month, two of which were given 3 gms. of chlorobutanol per day. One of the two animals receiving chlorobutanol increased his output of ascorbic acid by six times, but the other animal increased its excretion of ascorbic acid by only 20 mg. The other two that did not receive chlorobutanol decreased in ascorbic acid excretion to 45 mg. per day.

P20. The Effect of Thyroidectomy upon Growth, Appearance, General Behavior, and Reproduction in the Bovine. A. A. SPIELMAN,*

* Assistant Dairy Husbandman, Washington Agricultural Experiment Station, Pullman, Washington.

W. E. PETERSEN, AND J. B. FITCH, University of Minnesota, St. Paul.

Thyroidectomy was performed on five females and one male ranging in age from one to 45 months. Subsequent observations over a period of three years are presented to show the physiologic effects elicited by complete removal of the thyroid gland. Changes were observed in the general appearance and behavior which may be best described in the immature animals as "bovine cretinism" and in the older animals as "bovine myxedema."

Periodic analyses revealed the following changes in individual blood constituents: decreased hemoglobin and creatinine; increased blood fat and plasma cholesterol; normal variation of calcium, phosphorus and blood sugar.

In confirmation of earlier reports on other species, this study indicates that removal of the thyroid from immature bovine results in an almost complete stasis of skeletal growth and a drastic retardation of gain in body weight. Skeletal growth was resumed during the late stages of pregnancy due presumably to diffusion of the thyroid hormone from the fetus into the maternal circulation, or by some other undefined factor related to the pregnant state.

In most species, thyroidectomy has been shown to seriously interfere with reproduction. The absence of physical manifestations of estrus and male libido in sexually mature bovine was observed, although ovulation and sperm production continued for some 453 days after removal of the thyroid. Normal estral behavior in the females and normal breeding behavior in the male was elicited by thyroid therapy. Thyroidectomy either before conception or during pregnancy had no detrimental effect on gestation or parturition. The birth of three normal calves from completely thyroidectomized parents indicates that reproduction was not seriously impaired.

P21. The Effect of Thyroidectomy upon the Lactation of the Bovine.

A. A. SPIELMAN,* W. E. PETERSEN, AND J. B. FITCH, University of Minnesota, St. Paul.

Data on six lactations of four cows thyroidectomized at different stages of gestation and lactation are presented.

Two cows were thyroidectomized during the early part of the lactation period. Recovery from the effects of the operation as expressed in daily milk yield was uneventful and effected in about four days. The maximum daily milk yield was reached about 14 days sooner than was observed in the previous lactation with the thyroid intact. Daily milk production dropped

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rapidly and practically ceased at about 110 days after parturition. Total milk and fat production was reduced about 70 per cent.

Lactation data on three cows thyroidectomized before conception were accumulated. Graphic analyses of the data revealed a marked decline in milk and fat production and lactation periods of only about 195 days in length.

The effect of thyroidectomy on the production of milk fat was very similar to that produced on milk secretion. The daily fat yield curve was almost synonymous with the curve for milk yield. The same general trends and variations were evident for both milk and fat secretion. Although the fat percentage varied somewhat more than did fat yield, no significant deviations were evident.

No significant changes in the composition of the milk as determined by fat, lactose, protein, and specific gravity analyses were observed.

It has been pointed out that one of the methods of studying endocrine function is administration of the glandular substance to deprived animals. Milk and fat yields were increased to former levels by oral administration of fresh thyroid. However, decreasing response, apparently due to involution of the mammary gland, was observed as the lactation period progressed. The ability of the thyroidectomized animals to respond to thyroid therapy appeared to be contingent upon the interval of time between thyroidectomy and administration. Serious impairment of normal physiological processes resulting in loss of ability to respond to thyroid therapy apparently occurs.

The secretion of large amounts of milk is dependent upon an adequate supply of metabolites from the blood. An inadequate supply may be due to lower levels in the blood stream or to a decreased flow of blood through the mammary gland. Blood analyses on thyroidectomized lactating cows did not show any significant decrease in calcium, phosphorus, blood sugar, total nitrogen, or fat. Although blood flow was not measured, a lowered heart rate was observed.

Insofar as possible, the parathyroid glands were left intact, although the amount of functional parathyroid tissue each animal retained was not determined. Blood calcium levels remained within the normal range.

P22. The Hormonal Preparation of Dairy Cows for Lactation.* RALPH P. REECE, N. J. Agr. Expt. Sta.

Attempts have been made to induce and maintain lactation in 4 dairy animals by hormonal administration. All injections, except those of A2, were made subcutaneously twice weekly.

A 30-month-old Holstein-Friesian heifer, H22, received a total of 60 mg. of testosterone propionate plus 163 mg. of diethylstilbestrol dipropionate

* Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Dairy Husbandry.

over an 11-week period. During the injection period there was a gradual increase in udder and teat size, but at no time was the udder filled with secretion. In 228 days H22 produced 4791.4 lb. of milk with an average fat test of 3.82 per cent. The peak daily milk production was 27.5 lb.

A 33-month-old Jersey heifer, 381X received a total of 273 mg. of diethylstilbestrol dipropionate over a 14-week period. The first injection was made when the animal was in heat. At first there was a slight increase in udder and teat size and then the udder appeared to become slightly filled with secretion. The secretion was not removed and secretory activity seemed to subside. By the end of the injection period the udder had increased considerably in size but it was not distended with secretion. The heifer gradually came into milk production and during the first 26 days that she was with the milking herd and milked twice daily she produced 412.9 lb. of milk with an average fat test of 4.42 per cent. In the following 5 full months of lactation 381X produced, on the average, 912.1 lb. of milk with an average fat test of 4.79 per cent. She attained a peak daily production of 34.0 lb.

A 20-month-old Ayrshire heifer, A2, received 95 mg. of diethylstilbestrol dipropionate over a 5-week period. Weekly injections were made. There was only a very slight increase in udder size during the injection period. Daily milkings were begun 22 days after the first injection. The milk obtained on the first day was low in milk fat and high in solids-not-fat. The milk gradually became higher in milk fat and lower in solids-not-fat. Although the heifer was milked daily for 58 days she attained a peak daily production of only 0.2 of a lb. The average daily production for the 58 days was 0.07 of a lb.

A 3-year-old Jersey heifer, 384X, carrying a mummified fetus received a total of 35 mg. of diethylstilbestrol in 2 injections. A rectal examination 3 days after the second injection showed that the fetus had been expelled. The heifer was milked daily for the following 13 days during which time she never produced more than 0.1 of a lb. of secretion daily. After an 8-day dry period 384X received a total of 273 mg. of diethylstilbestrol dipropionate in 14 weeks. The udder and teats gradually increased in size during the injection period. Daily milking was instituted 14 days after the last injection, and on the 12th day of the lactation period the heifer produced 2.9 lb. of milk.

P23. Stilbestrol as a Stimulator and Inhibitor of Lactation.* C. W. Turner and Joseph Meites, Missouri Agricultural Experiment Station.

Stilbestrol has been demonstrated to stimulate the secretion of milk in cattle and goats. Its mode of action is by way of the pituitary. Injection

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 902.

of stilbestrol into experimental animals has caused an increase in the lactogenic hormone content of the pituitary which in turn stimulates the lactation process in the cells of the mammary gland. With increasing levels of stilbestrol administration, an optimum was reached where the lactogenic hormone in the pituitary was maximal, while beyond this level the lactogen was increased to a lesser extent.

While stilbestrol at high levels stimulates this increased secretion of the lactogenic hormone by the pituitary, it depresses milk secretion. An explanation of the depressing action of stilbestrol upon milk secretion has been sought. It has been observed that stilbestrol stimulates the enlargement of the adrenal gland and the secretion of cortin. Cortin in turn has the property of utilizing protein and amino acids for energy purposes with the resultant increased excretion of nonprotein nitrogen in the urine. This action of cortin decreases the availability of the precursors of milk protein. It is suggested that this action of stilbestrol on the adrenal is the cause of the depression of milk secretion when it is administered at high levels.

This same mechanism is believed to operate in a reverse order following parturition. The rise in milk secretion is correlated with a decline in adrenal cortex activity. Further it explains the mechanics of milk secretion depression during the retention of the placenta and during other pathological conditions which cause hyperplasia of the adrenal.

P24. The Influence of Diethylstilbestrol Dipropionate on the Lactating Mammary Gland of the Cow.* RALPH P. REECE AND JAMES M. MURPHY, N. J. Agr. Expt. Sta.

Four lactating dairy cows have been injected subcutaneously with varying amounts of diethylstilbestrol dipropionate and certain observations made on the milk obtained from these cows.

An Ayrshire cow, 449, in the eighth month of her seventh lactation received 50 mg. of diethylstilbestrol dipropionate on August 6, 1942. Her average daily production in pounds for 10 days prior to injection and for 3-ten-day periods after injection was 29.7, 23.7, 26.4, and 27.0 respectively. Although 449 had not shown abnormal milk on the strip cup during her current lactation, 4 days after injection she was producing flaky milk from all quarters. Bacteriological examination of quarter foremilk 49 days following injection, at which time the milk had returned to a normal macroscopic appearance, showed that 449 was infected in 3 quarters with hemolytic (bovine blood) staphylococci and the other quarter was uninfected. Five mg. of diethylstilbestrol dipropionate were injected October 6 and October 9. October 12 all quarters were producing flaky milk and the average daily milk production decreased from 22.0 to 18.9 pounds. Examina-

* Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Dairy Husbandry.

tion of quarter foremilk showed that the leucocyte counts had increased and that the infection status had remained the same.

A Jersey cow, 389X, in the twelfth month of her fourteenth lactation and infected in 4 quarters with streptococci, received 10 mg. of diethylstilbestrol dipropionate November 30, December 3, and December 7. Flakes were observed in the milk obtained from one quarter December 8–10 and from all quarters from December 11 to December 18 at which time the animal was disposed of. The average daily production for 10 days before and for 2-ten-day periods after injection was 7.3, 5.9, and 2.9 lbs. respectively.

A Holstein-Friesian heifer, H22, in the ninth month of her first lactation and an Ayrshire cow, 472, in the 13th month of her fifth lactation each received 10 mg. of diethylstilbestrol dipropionate on January 11, 14, and 18. Bacteriological examination of quarter foremilk (prior to injections) showed that the udder of H22 was uninfected in one quarter and infected with streptococci in the other three, and that the udder of 472 was free of infection in all quarters. Following injections, first flakes and then slugs were observed in the milk from all quarters of both the infected and uninfected cows. Milk production of H22 decreased from 19.1 to 11.4 pounds in the second week after the first injection and then returned to 17.4 pounds. Milk production of 472 decreased from 21.0 to 9.2 pounds in the third week after the first injection and then returned to 12.0 pounds. Milk chlorides, expressed as mg. of Cl per 100 ml. of milk, of H22 increased from 112.1 to 215.9 and then decreased to 130.0. Milk chlorides of 472 increased from 95.8 to 179.0 and then decreased to 110.4. H22 was again injected with 10 mg. of diethylstilbestrol dipropionate on March 27 and within 9 days all quarters were producing flaky milk.

P25. The Effect of Pitocin on the Lipolytic Activity of Mammary Gland Tissue. PHILIP L. KELLY, University of Arkansas, Fayetteville.

Experiments carried out with tissue from seven cow and four goat mammary glands show a relationship between the activity of tissue lipase and the hormone, pitocin. The *in vitro* experiments in which hydrolysis was carried out showed changes in lipolytic activity when the hormone was added. Usually this was increased, especially with gland tissue well advanced in lactation or in the dry period. Pitocin had no effect when the tissue lipase acted with fatty acids as substrates.

P26. The Effect of Thyroactive Protein on Growth Rate of Experimental Animals.* MARVIN KOGER AND C. W. TURNER, Missouri Agricultural Experiment Station.

The effect of mild hyperthyroidism on the growth rate of mice, rats, guinea pigs, and rabbits has been investigated by feeding graded amounts

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 900.

of thyroactive protein to growing animals, beginning with extremely small dosages.

As with previous work with thyroxin, mice responded to mild treatment with accelerated growth for a period of about five weeks. The growth curves of male rats were progressively depressed when amounts larger than 0.01 per cent of the ration were given while amounts smaller than this had no apparent effect on growth. Female rats were more tolerant of thyroid material. With 0.04 per cent to 0.08 per cent thyroprotein in the ration results with female rats were inconsistent. Larger amounts depressed growth rate. There was a marked difference in response to thyroid treatment of two different strains of rats.

The growth rate of rabbits was not apparently affected by amounts up to 0.02 per cent thyroprotein in the ration. Amounts larger than this depressed the growth curves of both males and females.

The growth rate of male guinea pigs was slightly but significantly increased for a period by feeding 0.0025, 0.005, and 0.01 per cent thyroprotein in the ration, after which time their growth curves fell below that of controls. The same amounts had no apparent effect on the females for a time, but after about three months, their growth curves fell below the controls. Larger amounts depressed the growth rate of both sexes.

P27. Practical Trials on the Use of Synthetic Thyroprotein for Increased Production of Milk and Butterfat.* E. P. REINEKE, University of Missouri, Columbia.

In recent reports from this laboratory it has been shown that by use of controlled conditions of production, it is possible to form preparations with high thyroidal activity by the simple iodination of casein and other proteins. This *synthetic thyroprotein* exerts 3 to 4 per cent of the calorigenic effect of thyroxine when given orally to guinea pigs. Following hydrolysis of this thyroprotein with alkali, more than 0.4 per cent of crystalline d, l-thyroxine has been recovered. By hydrolysis with acid approximately 0.1 per cent of pure l-thyroxine has been obtained from synthetic thyroprotein.

Previous research has shown that either natural thyroid material or thyroxine will cause a rise in both the milk yield and butterfat test when given to lactating cows. Thus it was believed that the inexpensive synthetic thyroprotein now available might provide a practical means of increasing the production of milk and milk fat. In order to test the effect of this substance under practical conditions, thyroprotein was supplied to a number of farmers in the vicinity of Columbia for use on a few cows in their herds. Thyroprotein has been given in amounts of 15 to 25 gm. daily per cow, or in the ratio of approximately 1½ to 2½ gm. per 100 pounds body weight.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 899.

Thus far, data have been obtained on 27 cows fed thyroprotein, distributed among 5 herds, and including Jerseys, Guernseys and Holsteins. All of the cows were in the declining stage of lactation when started. Twenty-three cows out of the 27 showed increases in milk production ranging from 6.6 per cent to 60.8 per cent after 6 days or more of thyroprotein feeding. Four cows showed no change in production. The average increase in milk production for the 27 cows fed thyroprotein was 18.6 per cent. In one Jersey herd of 4 cows a butterfat test was obtained immediately before thyroprotein was started, and a second test was obtained ten days later. During the seventh to twelfth day of thyroprotein feeding, the milk yield had increased an average of 26.2 per cent, and the average fat test increased from 5.2 per cent to 6.3 per cent. Consequently the average fat yield was increased 53.1 per cent during this period.

The cows in these herds have been fed thyroprotein continuously for periods ranging up to three months. After one to two months of elevated production, the normal decline of lactation occurs, but at a retarded rate, as compared to the normal.

It is known the feeding of thyroprotein in excessive amounts will cause undesirable effects such as hyperirritability and loss in body weight. With the amounts given in this trial, however, the dairymen failed to observe any unusual symptoms.

P28. Experimental Stimulation of Mammary Gland Growth in Female Goats.* JOHN P. MIXNER, University of Missouri, Columbia.

As there is some question whether progesterone and estrogen are both necessary for the complete development of the mammary glands of goats, normal virgin female goats were injected with progesterone plus diethylstilbestrol and others with diethylstilbestrol alone. The mammary glands were studied both by means of histological sections and by whole mounts of thin sections of the mammary tree. The last method was found to give the best picture of the state of mammary development.

Mammary glands of goats receiving 20 or 30 mg. progesterone plus 100 or 150 micrograms of diethylstilbestrol daily were stimulated to extensive lobule-alveolar growth in 60 days such as is seen at midpregnancy. Further treatment of the glands of such goats with diethylstilbesterol alone caused the appearance of secretion such as is seen at the time of parturition.

Goats which received diethylstilbesterol alone showed a development of the mammary glands which ranged from no lobule-alveolar growth to rather extensive lobule-alveolar growth. However, such growth was not histologically normal as shown by examination with high power magnification. Many abnormal papillae-like structures could be seen protruding into the lumina of the alveoli.

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 901.

These are the first studies with dairy animals which show the need for both progesterone and estrogen in causing complete mammary growth. These experiments indicate that although diethylstibesterol will cause varying amounts of lobule-alveolar growth of the mammary gland, the growth of the lobule-alveolar system occurring during pregnancy is probably accomplished by the joint action of progesterone and estrogen.

P29. The Action of the Milking Machine in Relation to Milking and Udder Injury. W. E. PETERSEN, University of Minnesota, St. Paul.

The rate at which milk was obtained by mechanical milkers was determined by suspending the milking machine pail from a scale and noting weights every 20 seconds. From these weights curves were constructed, from which the following generalizations are made:

1. When cows let down their milk completely the rate of withdrawal of milk by the machine was constant for any cow up to a certain point when the rates tapered off.

2. There was great variation in the rate of milking between cows which is roughly inversely correlated to the hardness of milking in most cases.

3. The point when tapering off of the rate of milk withdrawal also varied for individual cows as did the rate of the decline.

4. The amounts of milk not obtainable by the machine without special manipulation also varied greatly with individual cows.

5. Most cows milk out faster than is generally believed.

In an effort to obtain information on the reasons for the observed phenomena and the action of the milking machine upon the udder and teat, excised udders were used. These were suspended in the laboratory and skim milk or saline solution was infused, by gravity, into the gland cistern through an inserted cannula so as to maintain a pressure, simulating that when milk is let down. The rate of milk withdrawal is observed under varying conditions such as changes in vacuum, varying rates of pulsation and other factors for long periods of milking for both constant and diminishing fluid pressure within the gland cistern.

Incisions were made in the walls of the gland cistern so that a finger could be inserted to feel the action of the machine upon the tissues of the lower gland and upper teat. By insertion of a large glass tube, perpendicularly, through the gland directly over the teat the action could be seen. Insertion of a hard rubber tube, attached to a vacuum gauge, into the teat cistern enabled the determination of the vacuum developed therein by the machine action under varying conditions.

From studies made to date the following generalizations are made:

1. For any gland with a constant fluid pressure within the gland cistern the rate of milking is constant.

2. With decreased intra cistern pressure the rate of milk removal decreases. At the point when a decreased rate of removal was observed the teat cups began to crawl upward and the orifice between the teat and gland cisterns could be felt and seen to constrict.

3. For most glands, greater or lesser quantities of milk could not be removed by the machine without special manipulation.

4. Tugging with sufficient force upon the teat cups to bring them part way down on the teats caused complete evacuation of the gland cistern. This prevents closure of the orifice between the gland and teat cisterns.

5. When milk flowed freely from the gland cistern into the teat cistern no detectable vacuum within the teat cistern was noted. When the rate of milk flow slowed down vacuum was developed within the teat up to that in the milk tube.

6. Violent action upon the tissues of the upper teat and lower gland results from leaving the machine attached after milk flow ceases.

P30. Further Studies on the Nutritional Control of Milk Fever. W. E. KRAUSS, C. F. MONROE, JOHN HIBBS, AND T. S. SUTTON, Ohio Experiment Station.

The work reported at the last annual meeting was continued with little change in procedure but with some change in results. Whereas the previous report had shown very definite benefit (in Jerseys) in reducing the incidence of milk fever enough failures were encountered this year to reduce markedly the margin of difference in incidence between yeast-fed and normally-fed animals. When all breeds are considered 19 per cent of 58 freshenings occurring in yeast-fed cows and 20 per cent of 60 freshenings occurring in normally-fed cows resulted in milk fever.

In Jerseys, the breed in which milk fever occurs most frequently, yeast feeding seems to have been of some benefit. Of 35 freshenings occurring in yeast-fed Jerseys 17.1 per cent resulted in milk fever, whereas the incidence in normally-fed Jerseys was 37.5 per cent in 32 freshenings. This difference is somewhat emphasized by the fact that in the yeast-fed group 9 of 12 cows with previous histories of milk fever freshened normally whereas only 1 of 7 animals with previous histories in the normal group freshened normally.

That a breed difference in susceptibility to milk fever exists also is indicated by blood vitamin D studies. The vitamin D content of Jersey blood decreases markedly just before freshening whereas that of Holsteins does not.

Blood magnesium determinations were made at numerous intervals in the freshening cycle of several cows. It was found that blood magnesium rises significantly during milk fever and that an inverse relationship exists between blood magnesium and blood phosphorus.

P31. The Development of Ketosis in Dairy Cattle. J. C. SHAW, Storrs Agr. Exp. Station, Univ. of Conn., Storrs.

The blood picture was studied during the development of ketosis in a herd of dairy cattle for a four-month period during which 75 per cent of the cows, exclusive of first calf heifers, developed ketosis following parturition. Hypoglycemia and ketonemia usually began to develop within the first day or two following parturition although symptoms were often not detected until several days later. When the blood picture remained normal for as long as three days following parturition no ketosis developed. Several animals developed ketosis without showing any symptoms. The caloric intake was usually in excess of requirements both prior to and following parturition. Data on the concentration of blood glucose and acetone bodies prior to and during the development of several cases of ketosis of varying degrees of severity will be presented.

Glycogen reserves were estimated by the increase in blood glucose following the injection of adrenalin. There was a close relationship between the glycogen reserves and the level of blood sugar although the initial decrease in liver glycogen appeared to precede the development of hypoglycemia and ketonemia. The results of glucose tolerance tests and studies on the effect of ketosis upon lactation will also be presented. The data indicate that ketosis in dairy cows may be due to liver damage associated with conditions prior to parturition.

P32. The Value of Kelp Meal in Rations for Dairy Cattle.* M. H. BERRY AND K. L. TURK,† University of Maryland.

The value of adding kelp meal to dairy rations has been investigated with 74 dairy heifers. Heifers were placed on experiment at approximately one year of age and were continued through their first calving period. Fifty-two animals were kept on the experiment through a second gestation.

When placed on the experiment, the heifers were paired according to breed, age and size and were fed in dry lot. They received corn silage and U. S. No. 2 clover hay in amounts that would be readily consumed each day, plus 4 pounds of a concentrate mixture containing approximately 14 per cent total protein. Kelp meal was fed at the rate of 4 per cent of the concentrate mixture to one animal of each pair.

Results from the 37 pairs of heifers completing their first gestation period showed no advantage in favor of either ration. Heifers in the control group made an average daily gain of 1.05 pounds and those in the kelp

* This investigation was supported in part by the Kelco Company, San Diego, California.

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group gained 1.03 pounds per day. In the control group, 1.45 services per conception were required, while 1.86 services per conception were required by the heifers receiving kelp. There were 2 abortions in each group, 5 cases of retained placentas in the control group and 2 cases in the kelp group, and 2 animals from each group were discarded as non-breeders. Heifers on the control ration had an average gestation of 276.5 days and those on kelp 275.9 days. Calves born to the kelp fed animals averaged 2.26 pounds heavier at birth than those from animals on the control ration. No significant differences were noted in physical condition of the animals at freshening or in the condition of the calves at birth.

For the 26 pairs of heifers which were continued through a second gestation period, the controls averaged 2.23 services per conception, while the kelp-fed animals averaged 1.92 services. There were 3 abortions and 2 cases of retained placentas in the control group, and 2 abortions and 4 cases of retained placentas in the kelp group. Calves born in the control group averaged 1.71 pounds heavier at birth. The length of gestation averaged 277.7 days for the controls and 275.4 days for the kelp-fed animals. No differences were noted in the physical condition of cows at calving or in the calves born to cows from either ration.

Lactation data showed no differences which could be attributed to the ration. On a 4 per cent fat-corrected-milk basis, the control cows averaged 8089.5 pounds of milk and the kelp cows averaged 7715.2 pounds. In both cases lactations averaged 303 days in length and the average age of the animals at freshening was 2.5 years. Feed consumption records showed no stimulating effect from the feeding of kelp and liveweight changes were slightly in favor of the kelp-fed animals during lactation.

P33. Artificial Breeding as a Means of Controlling Genital Infections in the Dairy Herd.* H. A. HERMAN, E. R. BEROUSEK, AND E. W. SWANSON, Missouri Agricultural Experiment Station.

Experiences in a dozen Missouri dairy herds covering a period of several years indicate that artificial insemination of dairy cattle may be practical and fairly efficient in preventing the spread of such genital infections as are carried by the bull. Studies with both large commercial herds of 300 to 500 cows as well as small farmer-breeder herds experiencing considerable breeding troubles have shown vaginitis and trichomoniasis to be major causative factors. Where bulls free of infections have been obtained, and the cows have received proper veterinary attention and had sexual rest, the use of artificial breeding only has resulted in the majority of infected cows becoming settled and the calving interval for the herd becoming shorter. In some of the larger herds studied, from two to eight services were being required per calf and many cows were calving at 2-year intervals. In one to two

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 905.

years following the adoption of artificial breeding, and in some cases disposing of trichomoniasis infected bulls, over 1500 cows in such herds were requiring from 1.7 to 2.1 services per calf. In several herds where part of the cows were bred by natural service and part by artificial method, the clean-up of genital infections has not been nearly so promising.

P34. The Effect of Dilution Rate on the Livability and the Fertility of Bull Spermatozoa Used for Artificial Insemination. G. W. Salisbury, G. H. Beck, P. T. Cupps, and Irvine Elliott, Cornell University.

In an endeavor to find the maximum limits of efficient dilution of bull semen with yolk-citrate, investigations were conducted to study the effect of dilution on the livability of spermatozoa when diluted at rates varying from 1 part of semen to 1 part of diluter up to 1 part of semen to 32 parts of diluter. The spermatozoa showed a decreased ability to maintain their motility with each increase in dilution rate. Spermatozoa in semen possessing higher numbers of spermatozoa, a large percentage of which were actively motile on initial examination, survived storage at higher dilutions better than did spermatozoa in semen of lower spermatozoa count and lower initial motility.

In field studies, when the semen was diluted at a predetermined rate based on the spermatozoa count and the percentage of motile spermatozoa in each semen sample, no differences were found in fertility between semen diluted at rates of 1 part of semen to 2 parts of yolk-citrate up to 1 part of semen to 14 parts of diluter. One ml. of semen was used and inseminations were usually made directly into the uterus. Over 3900 inseminations were involved.

In an investigation especially designed to eliminate arbitrary selection of the rate of dilution to be used for any satisfactory semen sample, no significant differences in fertility were found for semen diluted at the rates of 1 part of semen to 4, 6, 8, 10, 12, or 16 parts of diluter. Over 2700 inseminations were made, and over two times as many cows were bred with semen diluted at the highest rate as was bred with a similar volume of actual semen diluted at the lowest rate. Semen at all rates of dilution was used for as long as 6 to 8 days after collection. No observable differences were noted in the maintenance of fertility for the several dilution rates during the first four days of storage. For diluted semen used longer than this period, the number of inseminations was too few on which to base conclusions.

P35. Acid Resistance in Relation to Longevity of Bovine Spermatozoa. Solomon Margolin, New Jersey Agricultural Experiment Station, New Brunswick.

From 0.5- to 7.0-cc. portions of 17 fresh semen samples, taken primarily from one sire, were acidified by titrating with 0.1 N sulfuric acid until

sperm motility reached zero. pH determinations (with Beckmans pH meter) were made before the titration and again when motility was reduced to zero by the addition of acid. A pH drop ranging from 0.85 to 1.66 was observed.

The remaining semen from each sample was diluted with egg-yolk phosphate buffer to approximately 100,000,000 sperm per cc., and was then stored at 45° F. in 3-cc. volumes. Motility readings were taken at approximately 12-hour intervals on these samples till motility reached zero.

The longevity of the semen samples at 45° F. was correlated with the pH drop ("acid resistance"). A highly significant negative correlation coefficient of -0.9894 ± 0.0027 was found.

The experiment was repeated without controlling dilution of buffered controls, and motility estimation was made at 24 hour intervals. Only 0.5 cc. portions of fresh semen were used. A correlation coefficient of -0.6229 ± 0.0518 was observed for the fifty-four samples of semen collected from thirteen sires.

Correlations for individual sires:

Sire	*No. of Samples*	*Correlation*
E	3	-0.7987 ± 0.1162
M	4	-0.8721 ± 0.0738
O	3	-0.6949 ± 0.2158
T	3	-0.7464 ± 0.1793
V	5	-0.9492 ± 0.0254
X	6	-0.6839 ± 0.1414
100B	8	-0.8315 ± 0.0598
100Y	7	-0.5488 ± 0.1812
100Z	8	-0.5006 ± 0.1887

From these experiments it is concluded that the longevity of semen diluted with egg-yolk phosphate diluent is an inverse function of the acid resistance. The acid resistance test requires from 5 to 10 minutes to perform. Thus it is possible to estimate semen longevity before semen is shipped or stored. Since longevity of semen is a function of semen fertility, the acid resistance test suggests a method of estimating semen fertility as well as longevity.

P36. Breeding Efficiency in Dairy Cattle Bred at Various Stages of Estrus by Artificial Insemination. GEORGE W. TRIMBERGER AND H. P. DAVIS, University of Nebraska.

In order to provide additional information on the question of the optimum time for breeding by artificial insemination, an experiment was carried on for three years to determine the breeding efficiency of females bred at various stages of estrus and at definite periods immediately following estrus. Cows and heifers of the Jersey, Guernsey, Ayrshire, and Holstein

breeds in the University of Nebraska dairy herd were included in the experimental groups. Only females were selected that, as far as could be determined, had sound reproductive organs and were free from any disturbances or abnormalities in their genital tract as indicated by examination per rectum. Good quality semen from disease-free bulls that had a good breeding record was used and all services were by artificial insemination.

A heat expectancy list was used to good advantage for detection of cows and heifers in heat. A female was considered in heat if she was complacent to being mounted by other individuals. The females in heat were tested every two hours and this made it possible to determine within an hour the time of cessation of estrus. The majority of the females remained in heat about 18 hours and this figure was used for dividing the time in reference to breeding at the start, at the middle, and toward the end of the estrus period.

The different stages of estrus during which the females were allowed services were as follows: start of estrus in which the females were inseminated during the first six hours of heat and were required to be in estrus twelve hours after the insemination. For the middle of estrus the females were required to be in heat at least six hours before and six hours after insemination. In the group bred at the end of estrus the females were required to be in heat at least 12 hours before insemination and out of estrus six hours after service was allowed. Another group of females were bred in full heat as in middle of estrus but they were given another insemination after 24 hours. The groups bred after the end of estrus were inseminated at six, twelve, eighteen, twenty-four, thirty-six, and forty-eight hours after the cessation of heat.

Although the individuals were closely watched and observed very frequently, 22 per cent of the females in which conception failed to take place did not return in heat at the next expected period. Silent heat periods were frequently observed among these females but no intermittent heat periods were found.

A total of 295 cows and heifers were bred in the experimental groups during various stages of estrus. All experimental groups consisted of 25 females except the groups bred during the middle of estrus, toward the end of estrus, and six hours after estrus ended, these had 40 individuals in each group. The breeding results expressed as percentages of conception from one insemination in the females were as follows: start of estrus, 44.0; middle of estrus, 82.5; middle of estrus and rebred in 24 hours, 84.0; end of estrus, 75.0; six hours after estrus ended, 62.5; 12 hours after estrus ended, 32.0; 18 hours after estrus ended, 28.0; 24 hours after estrus ended, 12.0; 36 hours after estrus ended, 8.0; and 48 hours after estrus ended, none conceived. During the 35 months of this experiment, 194 females were bred by artificial insemination in the routine breeding in the University herd, and

123 or 63.4 per cent of the females conceived at the first insemination. This large group can be used as a normal standard for a basis of comparison.

The results obtained indicate the potential benefits in higher percentage of conception in females bred during the middle of estrus, toward the end of estrus, and those bred in full heat and rebred in 24 hours. The latter is usually not very practical, especially in artificial breeding rings, but there are occasions when it may be desirable to follow this procedure. The results also show that a good rate of conception is obtained in females bred as late as six hours after the end of estrus. The low rates of conception in experimental groups bred long after the end of estrus indicate that it is seldom practical to breed females later than six hours after heat ends. Statistical treatment of the data verified these conclusions.

MANUFACTURING SECTION

SYMPOSIUM PAPERS

1. **Whipping Cream of Low Fat Content.** H. H. Sommer, University of Wisconsin, Madison.

The prospect of producing a whipping cream of low fat content by normal methods becomes hopeless when we consider the problem in terms of its fundamental factors. In whipping cream stiffness is attained as the two dispersed phases,—air cells and fat masses, become contiguous. If the dispersed units were spherical and all of the same size the dispersed phases would have to occupy 74.04 per cent of the total volume in order to be contiguous. In a 32 per cent cream this would require an overrun of 117.6 per cent, while in a 19 per cent cream the overrun would have to be 184.3 per cent.

Insofar as the fat masses are smaller than the air cells the fat tends to be accommodated in the interstices between the air cells and the overrun would have to be correspondingly higher to attain contiguity and stiffness. The function of the whipping act is to incorporate air, to sub-divide the air into the smallest possible air cells, and to coalesce the fat into larger masses, thus approaching a condition where air cells and fat masses are more nearly of the same size, and contiguity causes stiffness.

In 32 per cent whipping cream the overrun at the optimum whip is never as low as 117.6 per cent. This is due to the fact that the fat masses are not spherical and are smaller than the air cells. Accordingly, the dispersed air cells have to make up a larger part of the total volume to establish contiguity, and the overrun is usually from 140 to 170 per cent. It has been observed that the stiffest and most permanent whipped cream has a lower overrun,—one that approaches the theoretical overrun for spherical contiguity.

The question as to the optimum whip and the point where it occurs involves the release of a "foam breaking substance" (presumably lecithin)

from the fat globules in the process of coalescence and churning. This limits the volume of air and tends to cause larger air cells. As we try to attain substantial equality in size of air cells and fat masses the "foam breaking substance," released incidental to building up the fat masses, makes further progress in air incorporation and sub-division impossible.

In a 19 per cent cream the volume of air that would have to be incorporated to attain stiffness by contiguity is so large that release of the "foam breaking substance" limits the further air incorporation and sub-division far below the point required for contiguity, and whipping failure is the inevitable result. Only when we attain the whipped state by effervescence, by the escape of a gas from solution on release of pressure, is it possible to attain a stiff whip in 19 per cent cream, because the gas cells are very small and the volume of gas that will be retained is not limited by release of a "foam breaking substance" from the globules as in mechanical whipping (and churning). Even so the physical properties of the whipped cream inevitably reflect the fact that a very large portion of the dispersed phase consists of non-rigid air cells rather than rigid fat masses. Building up the viscosity of the plasma by increasing the milk-solids-not-fat content or by the use of hydrophilic colloids (gelatin, gums or starch) improves such low fat cream whipped by effervescence. The use of such substances in 19 per cent cream also permits the attainment of a fairly satisfactory whip by mechanical whippers. However, the whipped cream differs from customary whipped cream in that stiffness is due largely to the high viscosity of the plasma and not to contiguity of the dispersed air cells and fat masses.

2. Butteroil and Its Stability. G. E. Holm, P. S. Schaffer, and H. S. Haller, Division of Dairy Research Laboratories, Bureau of Dairy Industry, Agricultural Research Administration, U. S. Department of Agriculture.

The spoilage of oils and fats may result from enzyme action or from oxidation, or both. The former action can generally be provented by destruction of the enzymes with heat, while the latter can be prevented only by the exclusion of oxygen.

The removal of oxygen dissolved in a butteroil to a concentration which will not affect spoilage, is relatively difficult, but can be accomplished with agitation of the fat under vacuum. The ease of the removal of oxygen is also dependent upon the temperature of the fat, but does not seem to be of the nature of a direct function over the range of temperature of 10° – 80° C. The most complete removal of gases was accomplished with use of temperatures within the melting point range of the fat or at relatively high temperatures.

Butteroils of a dissolved oxygen concentration of less than 0.50 per cent by volume, sealed in an atmosphere of nitrogen, will remain in good condition

for a long period even under what would generally be considered severe conditions of storage.

3. Evaporated Milk of High Solids Content. B. H. WEBB, Bureau of Dairy Industry, U. S. Department of Agriculture.

An increase from 26 per cent to between 31 and 32½ per cent in the solids content of evaporated milk would save from 16 to 20 per cent in the containers and in the space required to store or ship this product. Such savings would be highly desirable under present wartime conditions.

The principal technical problem involved in the manufacture of high solids evaporated milk is one of heat stability. A satisfactory product can be made only when the concentrated milk is sufficiently stable toward heat to allow it to be sterilized without the development of coagulated protein. There are probably no evaporated milk plants which have a year around milk supply suitable for making high solids evaporated milk without the use of stabilizing salts when conventional forewarming temperatures ($< 212°$ F.) are used. Most of these plants could produce high solids milk through the use of high-temperature-short-time forewarming methods.

The heat stability of a milk, expressed as the time required to initiate coagulation at a given temperature, decreases logarithmically as the solids content of the milk is increased. If milk of 31 per cent solids content is to withstand sterilization at 115° C. (239° F.) its heat stability should be about 30 minutes. The same milk adjusted to 26 per cent solids content would have a stability of approximately 57 minutes, which is greater than normally occurs or is desired in milk of this concentration.

The heat stability of most milks of good quality can be greatly increased by high-temperature-short-time heating. This special heat treatment may be applied either before or after concentration of the milk in the vacuum pan. The stabilizing heat should be regulated primarily to obtain proper viscosity in the finished milk rather than to obtain maximum heat stability. The relationships between time and temperature of heating and heat stability have been determined. When high-short-time heating was employed as part of the forewarming process, a temperature of 120° C. (248° F.) for 3 to 4 minutes produced maximum heat stability. When high-short-time heating was used for the concentrate, 150° C. (302° F.) with no holding time gave maximum stability.

The problems involved in the control of body, color, and flavor of evaporated milk containing more than 26 per cent solids are similar to those involved in the production and storage of 26 per cent solids milk. The body of an evaporated milk usually thins during storage but the milk with the higher solids content remains more viscous. Some evaporated milks of 26 per cent solids and higher, when left in undisturbed storage for 8 months to a year, tend to thicken. This thickening is more pronounced in milks of

high solids content. The tendency toward the development of a dark color, a cooked flavor, and the formation of complex salt crystals during storage is slightly greater in high solids milk than in the commercial product.

To quickly attain high temperatures in fresh or concentrated milk, heating may be accomplished by the use of direct steam or of special types of tubular heaters.

4. War Restrictions Applied to Ice Cream. C. A. IVERSON, Iowa State College.

War restrictions applied to ice cream began early in the present war. The Ministry of Food in Great Britain at a conference on November 10th, 1939, held to fix allocations of butter for manufacture; ruled that at the outset no allocations should be made for ice cream. Restrictions in Great Britain, therefore, on ice cream were numerous, among them being the rationing of sugar to ice cream manufacturers effective January 8th, 1940, the prohibition of the use of cream in ice cream October 1st, 1940, the prohibition of the use of fresh milk including skimmilk in ice cream December 1st, 1940. The culmination of the restrictions was the conference with the Minister of Foods on July 30th, 1942, which resulted in the prohibition of the production of ice cream after September 30th, 1942.

Since Pearl Harbor there have been many restrictions placed upon the ice cream industry in this country. Fortunately there has been the recognition that the situation here, in several respects, is quite different from that in Britain. The restrictions have, therefore, been not nearly as drastic. In general, there have only been three orders applying to ice cream directly; *i.e.*, the limitation on sugar early in 1942, the restriction on gallonage production in December, 1942, and January, 1943, based upon October, 1942, gallonage and Food Distribution Order No. 8 in February, 1943, limiting the use of butterfat and milk solids not fat in ice cream. Many other limitations have had an indirect effect however, and include, early limitations on cocoa and pineapple, the general rationing of canned and frozen fruits, restrictions on paper goods, transportation, refrigeration, metal cans and equipment, etc.

With all of these restrictions imposed upon the industry and with volume demands upon the industry at an all-time high, it is only natural that the industry would resort to various methods to maintain volume. Many of these methods are now and probably will continue to have repercussions which may be unfortunate for the ice cream industry and, therefore, for the dairy industry as a whole.

5. War Restrictions in Relation to Ice Cream: Ices and Sherbets. J. H. ERB, Ohio State University.

The federal order limiting the quantity of milk solids to be used in ice cream is giving great impetus to the production of other frozen desserts,

such as ices and sherbets. Before the war, sherbets and ices contributed about 2 per cent of the total frozen dessert production while now it will probably amount to 15 per cent to 20 per cent.

The quality of ices and sherbets has not been standardized to anywhere near that of ice cream and considerable variation exists in character between the product of various factories and even in the product put out from day to day in any one factory.

The common defects of these products are in flavor and body and texture. Fruit flavors are almost universal and give best results. Fresh or cold packed fruits are most satisfactory, and in order to produce a high quality product, their use in good quantity should be promoted and the use of extracts discouraged. The natural acidity of the fruit must be reinforced because the intensity is diluted by the other constituents of the mixture.

Citric acid has been used heretofore most commonly to supplement the acid but due to its scarcity, other acids, such as lactic or a food grade of phosphoric are being satisfactorily utilized. Titratable acidity is not the best guide to intensity of acid taste in ices and sherbets, but rather one should follow by means of pH the degree of acidity of the pure fruit itself.

Good body and texture is dependent upon the following: (1) The type and amount of solids; (2) The amount of air incorporated; (3) The kind and amount of stabilizer; (4) The freezing point in relation to the temperature of dipping.

Formerly sucrose and dextrose have been the principal source of solids in ices while sherbets have contained in addition some milk solids. More recently corn syrup which contains dextrins, maltose and dextrose has been used advantageously to supply solids. Other solids of cereal origin also are being successfully used. The decision as to kind, proper balance and amount of the various solids must be from the standpoint of effect on: (1) Body and texture; (2) Sweetness; (3) Freezing point.

A total solids content of 30 to 33 per cent has proved very satisfactory, while the sweetness should be equivalent to 20–25 pet cent sucrose.

The kind of stabilizer exerts a great influence on air incorporation, especially in ices. Surface active materials are necessary for satisfactory whipping and small air cells. Gelatin is the best stabilizer when freezing in the continuous freezer where the overrun can be controlled to about 40 per cent.

The texture of sherbets ought to be almost as smooth as ice cream while an ice is usually slightly coarse.

RESEARCH PAPERS

M1. Studies on the Fat Globule Clustering Phenomenon in Milk. W. L. DUNKLEY AND H. H. SOMMER, University of Wisconsin.

In a series of studies on the clustering of fat globules in milk the roles of gravitational factors, interfacial energy and "fat agglutinin" were inves-

tigated. The finding of Sharp and Krukovsky that milk contains a substance that promotes cluster formation to a marked degree has been confirmed and extended. For the sake of convenience and without prejudice as to the mechanism involved, this substance is designated as "fat agglutinin."

A water suspension of fat agglutinin can be prepared by washing cream containing solidified fat by repeated dilution with cold water and reseparation, and finally warming the washed cream to liquefy the fat and again separating. The washed cream plasma obtained at this higher temperature is very active in promoting globule clustering. The agglutinin activity is removed with the euglobulin by the addition of 14.2 gms. of sodium sulfate per 100 cc. of plasma at 37° C. When the euglobulin is dialyzed and restored to milk containing little agglutinin, a marked increase in creaming properties results. When the euglobulin is added to cream poor in agglutinin and the volume made up with distilled water, a low concentration of salt must also be added to promote the agglutinin activity of the euglobulin. Dried preparations of the euglobulin which retain their agglutinin activity have been prepared.

M2. Effect of Pasteurization Times and Temperatures on Certain Properties of Cream. J. C. HENING, New York State Agricultural Experiment Station.

Studies have been made of the effect of a series of times and temperatures of pasteurization of cream on the phosphatase test, *Escherichia coli,* viscosity, whipping, separation of skimmilk, and flavor.

The temperatures of pasteurization used ranged from 143° F. to 170° F. with brief pre-heating periods.

A semi-logarithmic relationship between the time and temperature of pasteurization was found for phosphatase inactivation and the destruction of a heat resistant strain of *Escherichia coli.*

Longer holding periods were required for cream than milk to obtain similar inactivation of phosphatase and destruction of *Escherichia coli* at temperatures of 143° F. through 155° F. Temperatures of 165° F. and 170° F. with a 3 seconds holding period gave similar and satisfactory results for both milk and cream.

None of the times and temperatures of pasteurization of cream used in these experiments reduced its viscosity to any appreciable degree, injured its whipping properties, increased the separation of skimmilk or produced a heated flavor.

From these studies a temperature of 170° F. with a 3- to 10-second holding period is indicated as satisfactory for the pasteurization of cream.

M3. Chlorine Resistance of *Pseudomonas putrefaciens*. H. F. LONG AND B. W. HAMMER, Iowa Agricultural Experiment Station, Ames.

The occasional failure to control outbreaks of the putrid defect in butter by treating butter wash water and/or plant equipment with chlorine suggested a study of the chlorine resistance of *Pseudomonas putrefaciens;* this species is a common cause of the putrid defect. The difficulty in growing the organism on culture media greatly complicated the problem and, accordingly, attempts were made to find the conditions under which it grows best.

When suspended in sterile distilled water or in pasteurized and filtered well water, *Ps. putrefaciens* was rather easily destroyed by chlorine in the form of hypochlorite, provided excessive numbers of the organism were not present. With distilled water destruction was especially active and 1 ppm. chlorine usually was effective in 5 seconds. With well water the results were more variable, but 5 ppm. chlorine usually destroyed the organism in 5 seconds. When the numbers of the organism in relation to the amount of chlorine or its period of action were excessive, destruction was unsatisfactory. Among the strains tested there was some evidence of variation in chlorine resistance.

Agreement between growth of *Ps. putrefaciens* on a special agar and production of the putrid defect in unsalted butter at 21° C. was excellent. However, suspensions of the organism which yielded good growth on the agar often failed to produce changes in litmus milk.

M4. Isolation of *Bacterium linens*. OSCAR ALBERT, Dairy School, Dept. of Agriculture, St-Hyacinthe, Quebec, Canada.

A method was developed for the isolation of *Bacterium linens* from various sources. A special cheese agar including different salts as potassium citrate, sodium oxalate and five per cent sodium chloride was successfully used as a selective medium. An arragnement was made permitting the incubation of cultures in an atmosphere of oxygen. With this procedure *Bact. linens* develops readily and the colour production was much more intense than when standard tryptone glucose extract agar was used and plates incubating in the air.

In this study, various sources including cheese, milk, cream, feed, silage, water, mouth of cow, manure and soil were investigated. The organism was specially found in large number in soft cheese, feed from the manger, manure, mouth of cow, milk and cream. Several samples of garden soil examined did not show the presence of *Bact. linens.* A total of 220 samples out of 283 investigated yielded the organism.

The results show that *Bact. linens* is widely distributed in dairy products and is also present abundant in many other sources. The organism can be

easily isolated with the use of a special cheese agar and with an incubation made in oxygen atmosphere.

M5. Significance of the Coliform Group of Bacteria in American Cheddar Cheese. M. W. YALE, New York State Agricultural Experiment Station, Geneva.

The development of coliform bacteria during the manufacture of cheddar cheese and the length of survival of these organisms at a curing temperature of 10° C. (50° F.) were determined for 35 experimental lots of cheese of which 12 were made from raw milk and 23 from pasteurized milk. Coliform plate counts were made on violet red bile agar.

Growth of coliform organisms between rennetting and milling was rapid, the average generation time being 37 minutes in the case of raw milk curd and 48 minutes in the case of pasteurized milk curd. Six lots of raw milk from a cheese factory supply yielded coliform counts ranging from 20,000 per ml. to 2,100,000 per ml., while the freshly milled curd ranged in coliform count from 9,900,000 per gram to 410,000,000 per gram. These lots of cheese were gassy and inferior in all respects to cheese made from this milk after heat treatment for 30 minutes at 135°, 140°, and 143.5° F. Heat treatment of the milk at these temperatures and also at 155° and 161° F. for 15 seconds destroyed coliform organisms in 1 ml. quantities.

Slight contamination of the pasteurized milk from the cheesemaking equipment resulted in coliform counts which ranged from 900 per gram to 57,000 per gram of curd. The quality of the pasteurized milk cheese was not appreciably affected by the presence of these organisms.

The rate at which the coliform organisms died off varied greatly with different lots of cheese so that the coliform count of cheese a few days or a few weeks old was not an accurate index of the initial coliform content. At a curing temperature of 10° C. (50° F.) coliform organisms survived 10 to 12 months when the initial coliform content was high and where the pH did not fall below 5.0.

Growth of coliform organisms between rennetting and milling was markedly checked by developing an acidity of 0.25 per cent in the milk before setting or by adding three per cent or more of starter. Four commercial lactic cultures developed acid more rapidly at 100° F. than at 102° or 104° F. whereas the rate of growth of *Escherichia coli* was not affected.

Cultures of *Escherichia coli*, *Aerobacter aerogenes* and *Aerobacter cloacae* tolerated eight per cent but not nine per cent of salt. Addition of one per cent salt to milk increased acid development by commercial lactic cultures and also the growth of coliform organisms whereas two per cent salt yielded opposite results.

M6. The Quantitative Determination of Lactose-Fermenting Yeasts in Sour Cream.* E. R. GARRISON, University of Missouri, Columbia.

The dilution method using acidified whey with a pH of 4.0 and incubating one set of inoculated tubes at 25° C. and the other set at 37° C. for 6 days, then examining for gas production (after shaking) was found to be a satisfactory procedure for determining the numbers of lactose-fermenting yeasts in sour cream. The whey obtained from rennet coagulated skimmed milk was acidified to pH 4.0 by the addition of 85 per cent lactic acid, steamed for 30 minutes, filtered, the reaction again adjusted, then resteamed and refiltered; approximately 10 ml. of the whey was placed in Durham fermentataion tubes (with inverted tube supported on a small wooden stick about 10 mm. longer than tube), the tubes plugged with cotton, then steamed for 20 minutes.

The optical rotation of the whey was not changed by the heat treatment. The addition of peptone or yeast extract to the whey gave no advantages. Broth prepared from lactose, beef extract, peptone, yeast extract and water gave comparable results to those obtained with whey.

Cultures of *Escherichia coli* and *Aerobacter aerogenes* inoculated into the acid medium failed to produce gas or show evidence of growth. Lactose-fermenting yeasts were easily isolated from the tubes of whey that developed gas following inoculation with cream, by plating on potato dextrose agar at pH 3.5 and picking the colonies that developed into litmus milk. The reaction of the whey in the inoculated tubes usually showed no significant change during the incubation period but with a few samples, changes of $\pm$ 0.25 in pH were noted. Whey with a pH of 3.5 was too acid to permit the formation of gas by some of the lactose-fermenting yeasts in sour cream; these cultures grew on potato dextrose agar at pH 3.5, however, since colonies picked from the agar plates poured with these cream samples produced gas in litmus milk and in whey at pH 4.0. The lactose-fermenting yeasts in some cream samples developed gas in the acidified whey at 25° C., but not at 37° C. and vice versa; each of these incubation temperatures was, therefore, used, although a single intermediate temperature would probably be satisfactory.

Fifty samples of sour cream were collected at a cream station at monthly or shorter intervals over a period of 16 months and the lactose-fermenting and total yeast counts determined. The age of the samples varied from 4 to 14 days but most of the samples were delivered at intervals of 7 days. The percentage of samples collected in the different months of the year that contained 10 or more lactose-fermenting yeasts per ml. was as follows: January 36, February 37, March 50, April 49, May 46, June 80, July 72, August 80, September 82, October 54, November 46, December 43. Twelve and one-

* Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experimental Station, Journal Series No. 904.

half per cent of all samples examined contained 10,000 or more lactose-fermenting yeasts per ml. There was no close relationship between the total yeast count and the numbers of lactose-fermenting yeasts in the cream samples; many samples with yeast plate counts of 500,000 or more contained less than 10 lactose-fermenting yeasts per ml.

M7. Mold Mycelia Retained by Butter, Buttermilk and Wash Water During Manufacture of Butter. P. R. ELLIKER, Purdue University.

Retention of mold mycelia by butter, buttermilk and wash water was studied by means of a method that measured the total length of mold filament visible with 100× magnification. The method consisted of diluting the sample with hot gum solution, spreading 0.1 ml. of the mixture over one-half of a 26 × 77-mm. slide, drying and staining with a Newman or modified Newman stain. The total length of filament in each field was determined with the aid of a Howard micrometer disc, the average millimeters of filament per field calculated and from this the total length of mold filament determined per gram or kilogram of sample. Covering the smear with a thin film of immersion oil aided materially in recognizing the mold filaments.

Results by this method on both laboratory and commercial churnings indicated that the greatest percentage of the mold filament capable of contributing to a mold mycelia count was usually retained by the butter. In various trials, from 50 to 90 per cent of the mold accounted for in butter, buttermilk and wash water was present in the butter. Following is a typical example of results on a commercial churning: Butter retained 72.9, buttermilk 25.6 and wash water 1.5 per cent of total visible mold. Filaments of medium and great length appeared to be retained in the butter, and short, completely broken up segments tended to pass out into the buttermilk. There was some evidence that low fat content cream and a longer churning time, or both, resulted in more mold filament going over into the buttermilk.

M8. The Preservation of Sweet Milk and Cream on the Farm. R. N. DAVIS, University of Arizona.

Milk and cream sterilized at 15 pounds pressure for 20 minutes possessed good flavor after approximately three years storage at laboratory temperatures. Preheating to 180°–190° F. before adding to containers had a slight detrimental effect on the flavor. There did not seem to be any advantage in storing in refrigerator at 45° to 50° F. over storing at laboratory temperatures. There is little choice in containers but plain tins possibly gave better results than enameled cans.

Milk and cream of various fat content may be preserved but cream of 25 per cent to 30 per cent fat is most desirable. Very rich cream is hard to pour and may churn if whipped without diluting with milk. The whipping quality of the cream was fair.

The following are essentials for preserving cream:

1. Use only fresh sweet cream.
2. Pack into containers which may be hermetically sealed.
3. Seal and place in pressure cooker to sterilize.
4. Bring temperature to 245° F.—15 pounds pressure—leaving vent open until all the air is out of the sterilizer; and hold at this temperature for 15 to 20 minutes, depending on the size of the container. Take 15 minutes to bring the pressure up to 15 pounds. When the holding time is up turn off the heat and let the pressure go down before opening the vent cock.
5. When the pressure is down, remove containers and cool properly.

Shake the containers several times after they have cooled to break up any curd which may have formed. Turning the containers daily for a few days will help to prevent matting of the fat.

M9. Relation of the Feed of the Cow and Various Storage Conditions to the Types and Amounts of Carotenoid Pigments in Milk Fat. D. K. Bosshardt and O. F. Garrett, N. J. Agricultural Experiment Station, New Brunswick.

Oxidative degradation products of carotene and possibly of the xanthophyll fraction have been isolated and partially identified in the feed of dairy cows and also in the milk produced by these cows. Eight different bands of pigments were found chromatographically in milks produced on molasses green oat silage and corn silage. Seven bands were isolated from milk fat produced on green pasture.

The results showed that, although xanthophyll is a predominant carotenoid in the feeds, only a small portion of this is secreted into the milk thus confirming earlier reports.

Storage of butter that was contaminated with copper and with a combination of copper and manganese resulted in the destruction of a considerable proportion of the alpha and beta carotenes and an increase in the amount of some of the other pigments indicating that these latter were degradation products of the carotenes. This degradation was inhibited somewhat by addition of the fat-soluble antioxidant, hydroquinone.

M10. The Alkalinity of Milk Ash and Its Relation to the Detection of Neutralizers in Dry Milks. R. W. Kunkel and W. B. Combs, University of Minnesota.

A study was made of the method recommended by Hillig (Assoc. Off. Chem. Jour. **25**: 253–264. 1942.) for the detection of neutralizers in dry skimmilk. The method involves determination of the ash alkalinity of dry skimmilk and is dependent upon the fact that the previous addition of alkaline neutralizers increases the ash alkalinity.

Samples of unneutralized dry skimmilk were obtained from commercial drying plants to determine the approximate range of variation

which may normally be expected in the ash alkalinity of skimmilk. A total of seventy-six samples were obtained from twenty-four milk drying plants in Minnesota. These were analyzed and the averages of results obtained by duplicate analyses ranged from 76 to 127 and averaged 99.5, expressed as milliliters of 0.10 normal hydrochloric acid per 100 grams of sample. Although the normal variation in ash alkalinity was considerable, a large percentage of the samples had an ash alkalinity within a comparatively narrow range. Thus, more than 50 per cent of the samples had ash alkalinities within the range 95 to 105. These samples of dry skimmilk were obtained over a nine-months period, from July 1942 to March 1943, and during this time no significant seasonal variation was apparent.

The milk from different breeds of cows was studied and variations were observed in the ash alkalinity of the skimmilk from different breeds. The ash alkalinity of skimmilk from Holsteins was considerably higher than from Jerseys and Guernseys.

The effect of neutralization on the ash alkalinity of skimmilk was studied. It was found that the increases in ash alkalinity due to neutralization were roughly proportional to the amount of neutralizer added even when different alkalies were used.

The results of the study demonstrated that the method was fairly satisfactory for the detection of added neutralizers in skimmilk. The method enabled detection of 0.01 per cent neutralization if the ash alkalinity of the original unneutralized skimmilk was known. It appeared, however, that due to natural variations in the ash alkalinity of milk it would be possible to neutralize skimmilk considerably before it would be detectable if the ash alkalinity of the untreated milk was not known. Thus, the addition of neutralizers in amounts sufficient to reduce the titratable acidity 0.10 per cent may be possible without it being detectable by this method.

M11. Observations on the Use of Condensed and Powdered Sweet Cream Buttermilk in Ice Cream. E. L. THOMAS AND W. B. COMBS, University of Minnesota.

Experiments were conducted to determine the advantages and disadvantages of using condensed and powdered sweet cream buttermilk products as additional sources of milk solids-not-fat for ice cream. The experiments were conducted on a comparative basis, and condensed and powdered skimmilk were used as the additional sources of milk solids-not-fat for the control ice creams. In every comparison, both the sweet cream buttermilk and skimmilk products were derived from a single lot of mixed whole milk. All mixes were frozen in a 40-quart, direct expansion batch freezer.

The use of sweet cream buttermilk solids in ice cream mixes resulted in an improvement in whipping ability to the extent that the time required to attain an overrun of 90 per cent was reduced one to two minutes in com-

parison with control mixes which contained skimmilk solids as the sole source of milk solids-not-fat. This was true when either cream or unsalted butter was used as the source of butterfat for the mixes.

Ice creams which contained sweet cream buttermilk solids were observed to be drier in appearance and greater in consistency when freshly drawn from the freezer than the control ice creams.

Sweet cream buttermilk solids imparted to the ice cream a rich, creamy flavor which was lacking when swimmilk solids were used. It was observed that when roller process sweet cream buttermilk powder was used in mixes of a high milk solids-not-fat content there was an absence of a cooked or "custard-like" flavor which was always noticeable in the control ice creams.

In most comparisons, the drainage from the melting samples took place at a slower rate from the ice cream samples which contained sweet cream buttermilk solids. The ice creams which contained roller process sweet cream butermilk powder were characterized by foamy meltdowns, the foam in each case being greater in volume, finer in structure, and more glossy in appearance than that of the controls.

M12. Difficulties Encountered in Pasteurizing High Acid Milk for Cheesemaking. S. T. COULTER AND W. B. COMBS, University of Minnesota.

This constitutes a preliminary report of a condition encountered in the manufacture of Cheddar cheese from pasteurized milk in certain Minnesota factories. Despite fairly normal coagulation and acid development and adherence in manufacturing routine to the standard methods suggested by the Bureau of Dairying of the United States Department of Agriculture, the curd did not firm-up properly and the cheese consistently were graded down for weak body.

The condition was entirely alleviated by the addition of 0.05 per cent of $CaCl_2 \cdot 2H_2O$ to the milk prior to pasteurization. The ultrafilterable calcium content of this milk was slightly lower than that of milk from another factory known to yield satisfactory cheese and also lower than that of mixed milk from the University Herd.

The milk as received at this factory, however, was 2 to 4 days old and much of it was slightly sour. The acidity of the mixed milk over a period of 6 weeks ranged from 0.17 to 0.19 per cent. The possibility that the development of acidity in milk prior to pasteurization might influence the expulsion of moisture from the rennet clot was investigated. In three trials using split lots of commercial milk, the moisture content of the cheese made from milk in which 0.03 to 0.04 per cent acidity was developed prior to pasteurization was 0.5, 2.15 and 4.2 per cent, respectively higher than that of the cheese made from the normal milk. In four trials using small experimental cheese vats, the differences were 1.2, 0.75, 1.3 and 1.9 per cent respectively.

M13. The Influence of the Composition of Skim Milk on the Yield and Quality of Cottage Cheese. H. C. OLSON, Oklahoma Agricultural Experiment Station.

The yield and quality of cottage cheese made from high solids skim milk and from low solids skim milk were compared. The milk used in the various trials was from selected groups of cows or from selected individual cows. The cottage cheese made from high solids skim milk was superior in quality to the cheese made from low solids skim milk and the yields were considerably higher. The high solids milk produced a firmer coagulum, the acid developed more rapidly, the curd cooked more quickly and there was less mechanical loss compared to the low solids milk. The finished cheese from the high solids milk was of firmer texture and the individual particles retained their shape better than did the cheese from the low solids milk. Not only were the yields higher with the cheese made from the high solids milk, but the percentage of solids in the milk which was recovered in the cheese was also higher.

M14. Rate of Salt Migration in Cheddar Cheese Curd. W. H. HOECKER AND B. W. HAMMER, Iowa Agricultural Experiment Station, Ames.

Because of the effect of salt on bacterial action in cheddar cheese, the rate of salt migration from the surfaces to the centers of pieces of milled curd was investigated. The pieces of curd were taken from longhorn cheddar cheese in the press after 0, 5, 15, 24 and 48 hours and also after removal from the press about 24 hours. Microprocedures were used for determining the salt and moisture contents of samples, of approximately 1 to 5 mg. each, which were taken at the surfaces and centers of the pieces of curd. Also, pH determinations were run on samples of considerable size.

At the time of hooping, which was about 1 hour after salting, the salt contents at the surfaces of pieces of curd were relatively high, while at the centers the contents were very low and probably included only the chlorides from the original milk. During the early part of the pressing rather rapid decreases in the salt contents occurred at the surfaces, whereas at the centers there were conspicuous increases. After pressing for 15 hours the centers of the pieces of curd usually contained from 1.0 to 1.4 per cent salt. About 24 hours after removing a cheese from the press the difference in the salt contents at the surface and the center of a piece of curd was usually very small.

With the pieces of curd the moisture contents usually were higher at the surfaces than at the centers during the entire observation period. The greatest loss in moisture occurred during the first 15 hours of pressing after which the losses usually were very small.

pH determinations on the pieces of curd indicated that immediately before adding the salt the pH values were essentially the same at the surfaces

and centers. When hooped the pH values at the surfaces of the pieces of curd had increased slightly, whereas at the centers there were appreciable decreases. During the first 15 to 24 hours in the press, the pH values decreased rather rapidly at both the surfaces and centers, with the decreases being greater at the centers than at the surfaces during the first 5 hours. Late in the pressing the pH values decreased much more slowly, particularly at the centers of the pieces of curd.

M15. Fat Acidities of Cheddar Cheese Made With Added Lipase. F. J. BABEL AND B. W. HAMMER, Iowa Agricultural Experiment Station, Ames.

Without addition of lipase the fat acidities of cheddar cheese made from milk pasteurized at 143° F. for 30 minutes were rather low but they increased somewhat during the course of the ripening. Cheese made from different lots of milk showed variations in the original fat acidities and the increase during ripening varied considerably. Rancidity was not evident in the cheese.

With addition of lipase in the form of rennet paste to the pasteurized milk, the original fat acidities were rather low but the increases during the ripening were greater than when no lipase was added. Cheese made from different lots of milk with added lipase showed variations in the original fat acidities and also in the increases during ripening. Rancidity usually was evident in the cheese after 1 month, when the fat acidities still were rather low. In general, the rancidity was more pronounced with the larger amounts of rennet paste. With addition of lipase in the form of mulberry juice, the original fat acidities were low and there were conspicuous increases during ripening. There were variations in the original fat acidities and in the increases in acidities with different lots of milk and also great variations with the different lots of juice. When mulberry juice was added rancidity was not noted as soon as when rennet paste was added, but the fat acidities increased more rapidly. With the larger amounts of mulberry juice rancidity was more pronounced than with the smaller amounts.

There was little correlation between the fat acidities of cheese made with added lipases and the degree of rancidity. With approximately the same fat acidities, various cheese were classed as not rancid, very slightly rancid, definitely rancid and very rancid.

M16. Preliminary Studies of the Fatty Acids Involved in Lipolysis in Homogenized Raw Milk. I. A. GOULD AND B. C. JOHNSON, Michigan State College, East Lansing.

Relationship between the free fatty acid content of fat from homogenized raw milk and the rancid flavor in the milk was determined by two methods: (1) Permitting homogenized raw milk to undergo lipolysis to different levels

and then ascertaining the correlation between flavor of the milk and acid degree of the fat; (2) Incorporating into pasteurized skim milk, milk fat with high acid degree secured from rancid homogenized raw milk. Rancidity in homogenized raw milk was detected when the acid degree of the fat had increased to approximately 1.5. However, fat secured by churning cream from rancid milk did not, itself, possess a rancid flavor nor did it produce a rancid flavor when homogenized into pasteurized skim milk. Washing of fat secured from rancid milk with warm water did not materially alter the acid degree. However, washing of an ether solution of 50 grams of fat with six 20-ml. portions of 0.05 N NaOH solution removed 97–98 per cent of the fatty acids. Steam distillation of fat resulted in a recovery of approximately 5 per cent of the free fatty acids when the distillate volume was six times the original volume. In contrast, steam distillation of acidified alkaline washings from the ether-fat solution resulted in a recovery of approximately 32 per cent of the free fatty acids. Results indicate that the free fatty acids in butterfat secured by churning procedures are of the water-insoluble type and are not responsible for the typical rancid flavor of dairy products.

M17. Vitamin-B-Complex Preparations as Antioxidants in Milk and Milk Products. N. P. TARASSUK AND J. L. HENDERSON, University of California.

A liquid commercial preparation of a vitamin-B complex that was completely soluble in water was found by us to inhibit the development of copper-induced oxidized flavor in milk, when added to milk in concentration of 0.05 per cent or higher. A study was made, accordingly, of antioxygenic activity in milk of other commercial preparations of the vitamin-B complex sold as tablets, pills, and capsules.

The milk used in this investigation gave a typical strong oxidized flavor on aging for 48 hours when 0.25 ppm. of copper was added. In the absence of copper contamination, there was no development of oxidized flavor in the milk. To the experimental samples 0.5 ppm. of copper was added immediately before pasteurization at 142° F. for 30 minutes and after addition of the B-complex preparation. The milk samples were aged for 48 hours and were scored in duplicates as unknowns placed in random order.

The B-complex preparations were tested for antioxidant activity when added to the milk as (1) a suspension in milk; (2) a suspension in 2 to 4 per cent of distilled water, centrifuged to remove the insoluble material; (3) a suspension in water, centrifuged and autoclaved at 20 pounds for 30 minutes; (4) a suspension in phosphate buffer of various pH values, centrifuged. Several B-complex preparations were extracted with 95 per cent alcohol, acetone, and ether. The extracts and residues were tested for antioxidant activity in milk.

Out of 10 brands of B-complex preparations tested, 7 gave complete protection against the development of oxidized flavor when they were added as a milk suspension in concentrations of 0.05 to 0.10 per cent. The preparations imparted to milk a foreign flavor ranging from barely perceptible to objectionable. Dissolving in water and centrifuging an insoluble material, the amount of which varied from 40 to 70 per cent (depending on the preparation), reduced the antioxygenic activity. Buffer suspensions of the pH of milk or pH of 7.0 and centrifuged gave, however, just as good results as the milk suspensions. In buffers of pH 6.30 or lower, the antioxidant activity was decreased or entirely lost. Autoclaving or centrifuged solutions did not reduce the antioxidant potency of preparations. In a few cases, it enhanced it.

The crystalline B vitamins—thiamin chloride, riboflavin, pantothenic acid, niacin, pyridoxin, inositol, p-amino-benzoic acid, and biotin—when added to milk each separately or in the certain combination, failed to prevent the development of oxidized flavor in milk under our experimental system. The source of antioxygenic activity of vitamin-B-complex preparations appears to be, not the known crystalline B vitamins, but the yeast, liver, corn, and rice-bran extracts found in the various preparations.

The antioxidant factor (or factors) is extracted with alcohol, partially extracted with acetone and not with ether. The acetone extract of one preparation when added to milk in a concentration of 0.025 per cent gave complete protection against oxidized flavor, and the milk was free from foreign flavor. Though the alcohol extracts protected against oxidized flavor, they imparted foreign flavors, since the flavoring material of the preparations was also concentrated in the extracts.

Addition of one drop (28 mg.) of a liquid, water-soluble preparation of B complex to 5 cc. of pure, dry milk fat gave about a twofold decrease in the rate of peroxide formation under the accelerated test (79° C.) of fat stability. The experiments are under way to test and apply the antioxidant properties of B-complex preparations to whole-milk powder and to other milk products.

THE THIRTY-EIGHTH ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ
Secretary-Treasurer

The American Dairy Science Association assembled in Neff Hall on the University of Missouri Campus at Columbia, Missouri, on Tuesday, June 22, 1943, at 10:00 A.M.

Professor Arthur C. Ragsdale, Chairman of the Department of Dairy Husbandry, called the meeting to order and presented President H. P. Davis. He in turn introduced the following officers: Directors, Trout, Gearhart, Becker, Petersen; Editor, Sutton; and Secretary-Treasurer, Stoltz.

M. F. Miller, Dean of the College of Agriculture and Director of the Agricultural Experiment Station at the University of Missouri, was then introduced and delivered an address of welcome.

President H. P. Davis gave the following response:

PRESIDENT'S ADDRESS

Drawn by a common interest in the great dairy industry, we gather at this, the thirty-eighth annual meeting of the American Dairy Science Association, to pledge our hearts, our hands, our total energies to that foremost of all tasks, the winning of the fight for freedom. The younger, and more physically fit members of our association are already in the armed services in large numbers and many of us would welcome the opportunity to serve in such a manner. As it is we can do our part, and a vitally important one too, in advising, stimulating, and aiding in every way, the food front. In this home production of food, the role of the dairy industry is looming ever more and more important. Despite all the efforts that have been made to popularize alternative foods, it appears that Nature has endowed milk with such exceptional qualities that still there is no adequate substitute for it. It then behooves us to extend, yes, stretch our energies to insure that there shall be adequate quantities of milk produced and that none shall be wasted because of careless handling on the farm or in the factory. If "Food will win the war, and write the peace," then the dairy industry if it does its best can feel justifiable pride in its war accomplishments.

True Liberty Must Not Perish

In these disturbing times, in this struggle to preserve the rights of every man to enjoy his freedom, wartime restrictions have been imposed, which are recognized as essential. Travel has been curtailed, food is rationed, apparel is restricted, in fact our every day activities are far from free. Along with these inconveniences have come burdening taxes with more and heavier ones

in prospect. All these we accept with good grace, even gladness, for we feel that they are necessary to shorten this terrible holocaust. While realizing the necessity for wartime restrictions, we do resent arbitrary curtailment of liberty, stupid regulations, unnecessary regimentation, multiplicity of governmental reports, and most of all attempted changes in our business and economic life that are proposed by theorists under the guise of wartime necessity. Let us do everything possible to win the war, but at the same time let us not attempt a further social and economic revolution at least until the fighting is over. After all, is this not a conflict for the preservation of individual human rights?

What Is a Scientist?

Our association is named the American Dairy Science Association, having graduated from an early designation of Official Dairy Instructors Association. If it is a scientific association, then, certainly, its members should be scientists. That presents the question of what is a scientist? There are many definitions and considerable disagreement logically might develop about any definition proposed. Recently, however, a distinguished scientist[1] asked this question, "Are scientists distinguished for their knowledge or their wisdom?" That poses the problem of the definition of knowledge and wisdom and the differences if any between them. Can it be said that knowledge presupposes the mastery of a large number of orderly arranged facts? Under this definition, if, perchance, a man might acquire within his brain cells the total information that lies between the covers of a dictionary or encyclopedia, he might possess great knowledge. Certainly with such a compendium of facts at his disposal he would be informed on many subjects, but would that necessarily mean that he was a scientist? No, there is more needed than mere factual knowledge to be a scientist. While science may be defined as coordinated facts with attendant theories that man has fitted together in attempting to explain his own existence and his environment, a man with even great knowledge may not be a scientist. A scientist must of necessity have knowledge, for without it he has not the foundation, the building stones, for the construction of his understanding. In addition a scientist should have certain characteristics or attributes. He must possess curiosity, not just idle wondering, but a deep innate desire to know the workings of both the inorganic and organic spheres. An open mind as exhibited by freedom from prejudice; unlimited patience to probe and try many times if necessary in the search for truth; tireless energy that never flags no matter what the difficulties; and a passion for veracity that makes him critical of half truths and easy assumptions, all are characteristics of a true scientist. These, however, will be of little avail if in addition he does not possess com-

[1] Doctor Forest R. Moulton, Permanent Secretary, American Association for the Advancement of Science.

mon sense, and a true spirit of service. With all these qualifications, there still is one that is necessary for a great scientist. Possessing knowledge, a man may exercise his training, and his God-given gifts to fit together the pieces of the jig-saw puzzle, that is life, and if he attains a measurable success, he has wisdom. Let us all strive in our efforts to be scientists, to acquire not alone knowledge, but wisdom.

Science Must Be Explained

From time to time, it is seriously proposed that science should take a holiday in order that the general public should catch up, understand, and utilize facts that are already known. In support of such a proposal, it is pointed out that there is already a wealth of knowledge which could benefit the public if they understood its implications. Some may think of this as the suggestion of a crackpot amounting to pure folly, for they say, and rightly, too, that the world can never have too much knowledge. What, then, is the trouble, is there too large a quantity of undigested facts that is causing an intellectual headache in the population? Sometimes it seems as if the world were suffering from a failure of the people to utilize the information that is already available. Is there not a field here for us who strive to be scientists? Each month our own JOURNAL OF DAIRY SCIENCE is filled with the reports of research of our members in the field of dairy husbandry. Not alone our JOURNAL, but the many other scientific publications, and experiment station bulletins, carry other such reports of experimental work. In the field of dairy husbandry, there is not a belief that research should take a holiday, in fact the exact opposite opinion prevails. It is our universal conviction that only by finding out facts by continued research can the greatest understanding be obtained. Can it not be that those who ask for a research holiday, really want and need more interpretation of science? If that be the case, if we have *wisdom* and not just *knowledge,* our members as well as all who call themselves scientists, can render a great service to the public by pointing out the implications and the practical applications of research studies. Anyone who reads science journals, books, and monographs cannot help but realize that much of the language used is so technical that one needs have not only an unabridged dictionary, but perhaps even a chemical and medical dictionary also, to grasp the meaning of the report. For example, the application of statistical methods to scientific studies is relatively new, and those whose educational experience was more than two decades past had no knowledge of the meaning of Pearson r, Chi-square, or regression. If then this new technique is used to test the validity of an assumption or the relationship between factors, is it not in order to explain just what a certain mathematical expression means in everyday language? There is also the research worker who spurns the use of common terms in favor of highly technical expressions, doubtless believ-

ing that everyone has as great a technical vocabulary as his own, or perhaps he fears that in the use of simpler words, or the explanation of the more technical ones, he may lower his professional prestige. While this use of highly technical language may seem to be an evidence of erudition, it is in fact merely scientific snobbery. Some of the most fundamental scientific principles have been presented in simple style as witness, Darwin's "Origin of Species," which changed the world's thinking on biology; yet was written so that it could easily be comprehended. The argument that the average person cannot be expected to understand a technical paper is not valid, for if its writer really possesses wisdom, he can point out its implications and its everyday uses. That research results may be explained to the public in simple language is demonstrated weekly in the science column of the Sunday edition of the *New York Times*. As further evidence of the possibilities of simplification, may I call your attention to the subject of the Diety. Since the beginning of time, men have had conceptions about the Supreme Being that varied greatly. Religious ideas and ideals have probably caused more discussion and argument than any other single subject, nor have these arguments been friendly, for many persecutions and wars have been fought to convince, even by death, those who had a different creed. Surely, the conception of God is not uniform and neither is it simple, as witness almost any church creed, yet despite these complexities, it is taught to the kindergarten tots in Sunday School. If that can be done, cannot we help explain the results of scientific study in our own field so that the general public may understand? In dairy research let there not be a plethora of facts and paucity of understanding.

Education Needs Revamping

The present world cataclysm is not merely a war of global scope, it is also a revolution of economic and political ideas, in fact a revolution in attitudes toward life. In such an upheaval it cannot be expected that educational patterns can remain static. The United States obtained its basic ideas on higher education including technical training from German and from English universities. Both had developed types of education that doubtless were suited to those countries and conditions. In neither country has there ever been the conception that higher education should be offered to any large proportion of the youth of the nation. In our own country, through federal and state support for universities, public education in college and technical schools has been made possible to all qualified at comparatively low cost. The energetic boy or girl has been able to obtain a college education if he or she was willing to work hard even if funds were not available from parental sources. The public has had high hopes that youth thus instructed would become educated men and women ready and able to take their place in the country's affairs. Alas, the hopes perhaps were too high for there is de-

veloping a critical spirit on the part of the general public, that education, and especially higher education, has not accomplished what was expected from it. Perhaps the ideals were impossible, but there is a public wave of dissatisfaction with the knowledge, skills, and wisdom of those who have been educated at public expense. That presents the problem to those who are connected with educational institutions that present curricula and present methods of instruction ought to be critically reviewed. Our association has, after a series of years, completed a study of the curriculum in dairy husbandry, whether for production or manufacturing men. Into its preparation went many hours of thoughtful study by more than one hundred of our members. That it is not perfect and will not entirely satisfy all, may be readily admitted since it is difficult to ever attain complete unanimity among thoughtful men, but that it presents a suggested coordination and balance of courses is also readily apparent. It is believed that it will prove useful as a guide for dairy husbandry education, but not a panacea for all educational difficulties.

In education there must be more of the scientific attitude, the setting up of goals and testing to determine their attainment. The objectives of a curriculum and of individual courses are too frequently set forth in glittering generalities but with a lack of definiteness that makes them little more than high hopes. In setting up objectives, those for the college come first with broad general statements of integrated aims and ideals. These are next broken down into general field or departmental objectives which are necessarily more detailed. Then come the course objectives which should be elaborated into detailed aims for each week, for both lecture and laboratory periods. With a carefully planned integration of objectives, the stage is set for determining the effectiveness of the program. This testing involves the use of scientific criteria for finding out, step by step, the accomplishments of the teaching procedure in terms of facts acquired by the student, and the development in him of attitudes and the acquirement of skills. Let us not be self-satisfied, but ready to determine accomplishments in teaching by testing procedures. All of this may be summed up in the suggestions that teaching is bound to be vastly different, and more effective in the post-war period. The education of the future must orient men and women with their environment and in addition supply understanding, and teach skills. Dairy Husbandry instructors may well be studying these new tasks during the war.

Scientists Must Serve

The members of the American Dairy Science Association, as technically trained and widely experienced representatives of the dairy industry, have great responsibilities and equally large opportunities for service. Among their duties are those of setting up methods of improving the productive efficiency of dairy cattle. Dairy products manufacture have benefited by

improvements and refinements of methods that have raised quality and increased efficiency. But more important are the opportunities for service that lie ahead if we are alert and willing to serve. The production of the average milk cow is pitifully small and can be doubled by the application of known proved methods. For example, the use of artificial insemination in bull associations seems to offer an easy method, already tested for efficiency, of rapidly bringing about increased production. There are well-known procedures for feeding and managing cattle that will effect great increases in net returns to farmers. There are known methods for handling and manufacturing dairy products that if put into practice could vastly improve their quality and increase the efficiency of dairy plant operation. It is our duty to work toward bringing into general use these methods that can improve the industry. Ahead there lie a multitude of problems that must be solved if the dairy industry is to continue to furnish the food needed by peoples everywhere. Herein lies our opportunity, to search for new facts and better methods for use in the highly competitive field of food production, and to interpret and disseminate these findings, with the aim that dairying may continue to contribute to man's welfare.

Dr. George E. Holm, Chief of the Research Laboratories Division of the Bureau of Dairy Industry, was then introduced and gave the following address:

DAIRY SCIENCE AND THE WAR EFFORT

In normal times the dairy industry ranks as one of the largest industries in the country, if not the largest, from the standpoint of the value of its products. It produces over 100 billion pounds of milk annually, the sale of which accounts for over one-fourth of the farm income of the country—more than is accounted for by any other single product. The farm value of dairy products is approximately 2 billion dollars and their retail value is between 3 and 4 billions.

The phenomenal growth of the industry is apparent when we recall that the development did not begin until about 1850. Even in the year 1867 there were only slightly more than 8,000,000 milk cows in the United States and most of these were no doubt of the dual-purpose type. The trade in the products was local in character.

The real development of the industry began in the period of 1878 to 1890. These dates are significant because in 1878 De Laval invented the cream separator and in 1890 Babcock developed the fat test which bears his name. These developments made possible the quantitative evaluation of milk, which since the dawn of history has been valued principally for its fat content.

However, important as were these developments, let us not forget that the question of the use of milk depends upon the ability to keep it and its products in good condition for a marketable period of time. The development which made this possible was not industrial in nature but was the

result of advancements in our knowledge of the natural sciences and came at about the same period as the developments I have just mentioned. This was a result of work by Pasteur, and it is not necessary for me to enumerate what they were nor to speak of their far-reaching effects. It is sufficient to recall here the important role that pasteurization has played in the industry's development. These discoveries not only made possible a greater distribution and use of milk but also a greater distribution and use of butter which still was recognized as the principal product of the dairy industry. In fact, from the standpoint of trade the butter industry was the dairy industry.

The first attempt to preserve whole milk was that made by Gail Borden, in which he condensed the milk and used sugar as the preserving agent. This product was the industry's contribution to the solution of food problems during the Civil War. Its use was based on utility and not upon basic nutritional facts.

The next attempt at preservation of milk was the manufacture of evaporated milk, a product that is rendered sterile by the application of heat. The basic facts concerned in the manufacture of this product seem rather simple and matter-of-fact to us today. But, let us not forget that the development did not take place before the fundamental facts underlying the principles involved had been established by the work in bacteriology. Without this work the development would not have taken place at that time. It resulted in the industry's great contribution to the food problems of World War I.

At this point we might ask why dried milks were not used extensively during World War I and in the rehabilitation program that followed that war. The answer is that the war came too soon. It occurred at a time when our knowledge of these products was not sufficiently advanced to make dried whole milk generally marketable and before our knowledge of nutrition was sufficient to prove that dried skim milk is unique in its properties as an outstanding article of food.

In these developments alone we have ample evidence of how much an industry may depend upon developments in other fields. The quality of dairy products today is the result of application of bacteriological and chemical knowledge, and the high regard of the public for dairy products is the result of fundamental work in the field of nutrition.

The present war has brought new problems in the industry. First, there is the problem of producing sufficient milk to meet the demands of our armed forces and civilians and those of our allies. The industry has been called upon to produce 122 billion pounds of milk this year, which is 2.3 per cent more than was produced in 1942, 5.6 per cent more than was produced in 1941, and approximately 15 per cent more than the average annual production from 1934 to 1940, inclusive.

The extent to which we can make use of the large amount of knowledge available on breeding and selection is uncertain because of the time element

involved. The acquired knowledge on feeding, however, is of considerable value in our efforts to increase wartime milk production.

The dairy industry is faced with new problems in this war because of the greater demand for certain dairy products. In World War I the United States shipped mostly grains and cereals to the Allied Nations. Dairy Products accounted for only 1/50 of the food exported. In the present war milk products have accounted for 1/5 of the total deliveries to the Allied Nations to date.

Strangely enough, while there has been an increased demand for butter, this demand has not been greater than would be expected to result from the increase in consumer purchasing power. The quantity of creamery butter produced in 1942 was approximately equal to the annual production from 1936 to 1940. The goal for 1943 is approximately equal to the production in 1941 and 1942.

Greater emphasis has been placed on the other dairy products. The 1943 goal for cheddar cheese is 900,000,000 pounds, which is 60 per cent more than was produced in 1938 or 1939.

Three billion pounds of evaporated milk will be required this year, an increase of 45 per cent over the production in 1938.

Dried milks, because of the great saving in shipping space that can be effected by their use, likewise have been in increased demand. The Government has indicated the need for a production of at least 750,000,000 pounds of dried skim milk and 125 million pounds of dried whole milk this year. This would be approximately 50 per cent more dried skim milk and 100 per cent more dried whole milk than was produced last year.

After the war needs are provided for, the amount of milk that will be available for domestic consumption is expected to be about 103 million pounds, which is the same total amount produced in 1935. With a larger number of people buying milk, because of increased incomes, this simply means that civilian consumption of manufactured dairy products will have to be curtailed slightly in order that our armed forces and allies shall have the supplies they need. The major change is the use of milk to produce products containing as much of the nutritive value of milk as possible, rather than only part of it.

It is interesting to note that this is only a sudden intensification of the change that has been taking place slowly in the industry for a number of years. In 1933 the amount of milk used for the manufactured products was 46 billion pounds. In 1942 it was 61 billion pounds.

I have said that World War I came too soon so far as the utilization of dried milks was concerned. However, even had they been available it is quite certain that they would not have been used to the extent that they are in demand today. This is especially true of dried skim milk. Never before has the emphasis been placed on a product as an article of diet that is placed

on milk today. The underlying reason is again the advances which have taken place in the field of nutrition. Years ago the work in nutritional research raised butter to first position among the fats. In recent years it has shown that skim milk, in addition to its easily assimilable and greatly valued proteins, lactose, and salts, contains practically all of the known vitamins and some unidentified growth factors. And may I remind you again that this knowledge was a gift to the dairy industry as such.

But the problem of milk distribution among various products is not a problem of the dairy scientist. His problem is that of helping to produce the products needed for the armed forces, for lend-lease purposes, and for civilians. How have his efforts been of direct aid in bringing this about? May I illustrate this by calling attention to some of the work of our Bureau.

Shortly after Pearl Harbor all of its work was directed to aid the war effort. One of the first problems encountered was related to cheddar cheese. In some sections, as much as 40 per cent of the cheese produced was rejected for lend-lease purchase because it was not of the No. 1 grade. With a large increase in the production of cheese to meet the demand, an increase in the supply of cheese of No. 2 and undergrade quality seemed inevitable. And there was no increase in the domestic market for these grades. The obvious solution was to eliminate the production of No. 2 grade and undergrade cheese, and convert more milk into No. 1 grade cheese.

The possibility of producing a higher percentage of No. 1 cheese, by using pasteurized milk, had been studied for 6 years, both in the Bureau's laboratories and in the field and the results were available for use in the emergency. The methods established have been introduced in 9 states and have aided the manufacturers greatly in meeting the demands for No. 1 cheese. In one State alone, from which records are quite complete, the production of No. 1 cheese was raised from 31 per cent to over 80 per cent.

The situation with respect to some container materials is critical. Six years of work on the chemistry of lactic acid has produced methods for the preparation of several products that seem destined to find special uses. One of these is a resin that can replace tin as a coating material in many instances and which may find uses in many fields.

After years of study of the fundamental factors involved in fat spoilage and of studies to determine the properties of concentrated milks, methods have been developed for the production of butteroil that will keep without refrigeration and for the manufacture of evaporated milk of a total solids content of 32 per cent or more.

Years of study upon the constituents of whey have produced methods for the isolation of proteins and riboflavin (vitamin B_2) from the whey.

The point I wish to emphasize is, not that the work was done in the Bureau of Dairy Industry, but that the work was the result of years of effort in the study of fundamental problems relating to milk constituents. The

work which made possible these contributions to the war effort was not begun when war was declared. It was part of a program of fundamental research which had been in progress since the establishment of the laboratories. The few examples I have given are merely illustrations of the application of knowledge acquired, not in all cases with the thought of its immediate practical application.

Necessity may be the mother of invention in many cases. But no one can say that war brought the necessity for the discoveries which have made possible the excellent dairy products being produced. It did bring about the greater adaptation of the fundamental knowledge that had been accumulated over a long period of time. If this knowledge had not been available it would have been useless to try to obtain it for use during the war, for it is a known fact that on the average at least 5 to 10 years is necessary to bring a new development from the test tube to the factory stage.

Slosson has divided the ages of man into three periods—the appropriative, the adaptive, and the creative. Industries likewise may be classified according to whether they depend on the natural product in its natural form or in an adapted form, or whether they create an entirely new product. Many of the industries of today have passed the adaptive stage and are based on products of a creative age. In either stage of development pure science plays the principal role.

The X-ray was not discovered through a search for rays that would be of value in medicine. It resulted from work incidental to the study of the characteristics of light. The discovery of helium was a corollary to the work upon the atomic weight of hydrogen, and the electrical industry had its beginning in the work of Volta, Oersted, and Faraday. The application of these discoveries and of numerous others in the fields of alloys, dyes, plastics, organic chemicals, fermentation, etc., has revolutionized and created a number of industries.

No industry of today is safe from modifications and changes in forms of adaptation. Every industry must keep abreast in the scientific march of progress, in all fields as well as those in its own. Some of the largest and finest laboratories are maintained by large corporations like the American Telephone and Telegraph, General Electric, Western Electric, Standard Oil, du Pont, and other companies. There is little danger that these companies will be using antiquated methods or products or that they will be upset by revolutionary developments. The producers who survive are those who safeguard their processes and the quality of their products with research in both pure and technical lines.

Every industry passes through an intensive and an extensive phase. The coal, copper, lumber, paint, and rubber industries have all passed through these periods. They have all taken up the intensive side of production, not particularly because they wanted to conserve resources but because science

has developed new uses for their products and new methods of manufacture which these industries found profitable,—and perhaps necessary because of competition.

The dairy industry is in the extensive and adaptive phase of its development. Its numerous activities are problems in adaptation of the raw product to various uses. However, it is not enough that the industry should wait for developments. To fully protect itself, the dairy industry must take the initiative in these matters. Butter is a case in point. It was raised to the position of first rank among fats through the work in nutrition. Its position seemed secure until scientists showed that the yellow pigment in butter is a precursor of vitamin A and that it can be isolated from other sources and added to any fat to make its vitamin A content approximate that of butter. Many of us believe that butter has still other nutritive qualities that are not possessed naturally by other fats, but the butter industry is faced with the problem of having to prove the right to all that it claims for its product. Research is the price that will have to be paid. Work that should have been in progress years ago to protect this industry is just now under way.

There will always be problems in the dairy industry and these problems will not always be those created within the industry itself. They will be problems forced on the industry by advances in other fields. New products and new methods will always have their impact upon the industry and the industry must be prepared to withstand the impact. New products will alter our system of distribution and new methods will alter the efficiency of the processes now in use.

Therefore, the problems the industry should be thinking about and working on today are those for which a solution may be required 5 to 10 years from today. What are these problems? I do not know that anyone can give us an answer. But whatever they are, we can be certain of one thing; their solution will require the application of fundamental knowledge. Such knowledge should be sought whether its practical application is apparent or not. The dairy industry should assume its full share of support of this program of research, for in its adaptive stage it needs the results of fundamental work; and as it enters the creative stage, as it already has to some extent, this knowledge will be imperative.

With these thoughts in mind it may not be amiss here to touch upon the problem of training men for work in the field of dairy science. Back of all practices are fundamental or basic facts, and back of these are the members of what Little has called the Fifth Estate, those who "have the simplicity to wonder, the ability to question, the power to generalize, and the capacity to apply." These men are the pioneers, the men that every industry needs for its continued development.

The dairy industry has probably passed through a great part of its expansive stage. But in its adaptive stage, a better knowledge of the funda-

mental facts in genetics, nutrition, and in the physical and biological sciences, is imperative. The days when dairying was merely an art have passed, and we now depend upon scientific methods of production and control. As we apply the present knowledge in the adaption of products to our war needs let us not forget that training for the future development of the industry must go on. Training for these needs means training in the basic sciences.

Professor G. M. Trout, Chairman of a committee appointed to revise the Constitution and By-Laws, handed out to the membership the revision which was to be voted upon at the General Business Session Thursday P.M.

The President announced that any reports that were to be made at the next General Session should first be submitted to the Board of Directors.

There were 176 members present. The meeting adjourned at 11:45 A.M.

GENERAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

Columbia, Missouri, June 24, 1943

President Davis called the meeting to order at 3:00 P.M. in Eckles Hall, there being 86 present. G. M. Trout, Chairman of the Committee to revise the Constitution and By-Laws, moved and W. E. Krauss seconded that the revision as presented on Tuesday, and which is as follows, be accepted. Motion carried unanimously.

AMERICAN DAIRY SCIENCE ASSOCIATION CONSTITUTION AND BY-LAWS

ARTICLE I—NAME

Section 1. The name of this organization shall be the American Dairy Science Association.

ARTICLE II—OBJECT

Section 1. The object of the Association shall be to stimulate scientific research in all phases of interest to the dairy industry and to dairy science, to improve methods of dairy instruction and extension work, to cooperate in educational developments in advancing the general welfare of the dairy industry, and to make available through the JOURNAL OF DAIRY SCIENCE the results of the latest scientific research pertaining to these fields.

ARTICLE III—MEMBERSHIP

Section 1. Any person is eligible to membership who is filling a position of responsibility connected with the dairy industry or having an interest in the dairy industry who has had a college or university training in technical science, or any person filling a responsible position in the dairy or an allied

industry or field of a professional character requiring a technical knowledge of dairying of a high order.

Section 2. Nominations for membership shall be submitted to the Secretary-Treasurer in writing signed by the applicant and endorsed by one member. In case of uncertainty regarding the eligibility of the applicant for membership, the Secretary-Treasurer shall refer the application to the Executive Board for decision. Upon receiving the approval of the Secretary-Treasurer, or the Executive Board, when the application has been referred to them for action, and the payment of the membership fee and dues, the applicant shall be enrolled as a member of the Association.

Section 3. The membership fee shall be set by the Executive Board and shall be payable with the application for membership.

Section 4. The annual dues shall be set by the Executive Board and shall be payable on or before January first of each year.

Section 5. Any member of the Association failing to pay the annual dues by January first of each year shall cease to be a member of the Association. Lapsed membership in the Association may be restored without the formality of re-election either by payment of all arrears including the current dues or by payment of the affiliation fee and the current dues.

Section 6. Special cases concerning the eligibility for and restoration of membership shall be referred to the Executive Board for consideration.

ARTICLE IV—OFFICERS

Section 1. The officers of the Association shall be President, Vice-President, Secretary-Treasurer, Journal Editor, and seven Directors, one of whom shall be the Retiring President.

The Vice-President shall be elected by the vote of the membership and his term of office shall be for one year beginning with his installation either at the banquet or at the final session of the annual meeting following his election. In case an annual meeting is not held, the term of office shall begin July first. On the completion of his term of office as Vice-President he shall automatically become President for one year beginning either with his installation at the banquet or at the final session of the annual meeting, or in case an annual meeting is not held, on July first. The Secretary-Treasurer and the Journal Editor shall be elected by the Executive Board.

Section 2. The Executive Board shall consist of ten members including the retiring President, the President, the Vice-President, the Secretary-Treasurer and six members, designated as Directors, to be elected by the membership.

Two Directors shall be elected each year, whose term of office shall be for three years. The terms of all Directors shall begin either upon their installation at the annual meeting following election or on July first, in case an annual meeting is not held.

Section 3. Journal Management Committee. The Executive Board shall elect three members from the Association, who with the Secretary-Treasurer and the Journal Editor as ex-officio members, shall constitute the Journal Management Committee, which shall be responsible to the Executive Board. The Executive Board shall elect one member for three years, one for two years and one for one year, after which they shall elect one for three years, thus retiring one member each year. The term of service of the elected members shall be three years. Members may be elected to succeed themselves for one consecutive term only. The member having seniority of service shall be the chairman of the Journal Management Committee.

Section 4. The Executive Board may constitute and cause to be appointed such new committees of the Association as it deems proper.

Section 5. The Executive Board shall have authority to approve or disapprove nominations made by the President to fill vacancies that may occur among the elective offices of the Association, such appointees to serve during the remainder of the unexpired term of the office in question.

By-Laws

ARTICLE I—DUTIES OF OFFICERS

Section 1. The President of the Association shall preside at all meetings of the Association and the meetings of the Executive Board and shall perform such other duties as pertain to that office. As Chairman of the Executive Board, the President shall submit to the Executive Board for approval his nominations of members to fill vacancies that may occur among the elective offices of the Association. The President shall appoint without the Executive Board's approval the standing non-elective committees of the Association.

The Vice-President shall perform the duties of the President in the absence of the President.

Section 2. The Secretary-Treasurer shall have charge of the business management of the Association, shall have custody of the books and records of the Association, keep the minutes of all meetings of the Association and the Executive Board, maintain a list of all members and subscribers, keep the funds of the Association, submit an annual budget for consideration by the Executive Board, and make disbursements as authorized in the budget.

Section 3. The Executive Board shall pass upon all applications for the establishment of divisions, sections, and student branches of the Association.

Section 4. The Executive Board shall adopt an annual budget under which expenditures of Association funds will be authorized.

Section 5. The Executive Board shall have full control of the business of the Association, and the title to all property and funds of the Association shall be vested in the Executive Board. The Executive Board shall have all the rights and powers vested in the Corporation by the laws of the District of Columbia.

Section 6. The Journal Management Committee shall have the general supervision of the Journal. The Journal Editor under the general supervision of this Committee, shall have direct charge of all editorial details of the Journal.

ARTICLE II—ELECTION OF OFFICERS

Section 1. The President shall appoint a Nominating Committee consisting of five members, among whom shall be the retiring President, one representative each from the extension, manufacturing and production sections and one representing the commercial interests, whose names shall be published in the January issue of the JOURNAL OF DAIRY SCIENCE with appropriate facts to permit members to offer suggestions to the Committee. Members may suggest nominations to this committee up to April 1, for their consideration. On or before May 1 the Secretary shall mail to each member a blank on which he shall be entitled to express his choice for each office to be filled. This blank shall give the report of the Nominating Committee which shall suggest the names of two members for each office to be filled. All ballots shall be counted by the Secretary and later verified by the President. In case no candidate has a majority the tie shall be broken by the Executive Board. The results of the election shall be announced either at the banquet or at the final session of the annual meeting, or in case a meeting is not held, not later than July first.

ARTICLE III—MEETINGS

Section 1. Meetings of the Association shall be held at the time and place fixed by the Executive Board but not less than one shall be held each calendar year. Notice of the time and place of meetings of the Association shall be given to all members not less than four weeks prior to the date of the meeting. In case of an emergency the annual meeting may be cancelled by action of the Executive Board.

Section 2. Meetings of the Executive Board shall be held upon call of the President provided, however, that not less than 10-days notice of such meeting shall be sent to each member of the Executive Board.

Section 3. The quorum of any meeting of the Association shall consist of not less than five per cent (5%) of the membership.

ARTICLE IV—ORGANIZATION OF DIVISIONS

Section 1. Professional groups based on geographical considerations to be known as Divisions of the Association and to be organized by the members of the Association may be authorized by the Executive Board when such action shall seem expedient. The officers of the division shall be a chairman, and such other officers as are provided by the division.

The divisions shall have the right to make rules and regulations for their own government which shall not be inconsistent with the charter and the constitution and by-laws of the Association.

Membership in divisions of the Association is open only to those regularly elected members of the Association.

Any division may raise or collect funds to be expended for its own purpose.

Section 2. Professional groups based upon specialized interests to be known as sections of the Association and to be formed by not less than ten members may be authorized by the Executive Board when considered for the best interests of the Association.

Such sections may elect their own officers and may make rules for their own guidance not inconsistent with the Constitution and By-Laws of the Association.

Section 3. Student branches at any College of Agriculture may be authorized by the Executive Board on petition from at least ten students regularly enrolled in a four-year course in agriculture and majoring in some phase of the dairy industry when their petition is recommended by two department members who are members of the Association.

ARTICLE V—JOURNAL OF DAIRY SCIENCE

Section 1. The JOURNAL OF DAIRY SCIENCE, published by the Association, shall be sent to each member.

ARTICLE VI—AMENDMENTS

Section 1. This Constitution and By-Laws may be amended at any meeting of the Association by an affirmative vote of two-thirds of those members present, provided that not less than five per cent (5%) of the membership is present at the meeting.

All amendments must be referred to the Executive Board for its recommendations prior to the final action by the Association. The Executive Board may, at its discretion, submit proposed amendments which have received the approval of the Board, to the members of the Association for vote by mail. In such case, an affirmative vote of two-thirds of all voting, and which shall not be less than 25 per cent (25%) of the membership, shall be necessary for approval.

ARTICLE VII—EFFECTIVE DATE OF CONSTITUTION AND BY-LAWS

Section 1. This Constitution and By-Laws shall become effective January 1 following adoption.

Secretary R. J. Ramsey of the Manufacturing Section presented the following report. He moved and P. H. Tracy seconded that the report be accepted. Motion carried.

MANUFACTURING SECTION

Papers Presented: The scheduled program of papers was presented with the exception of the following, which were not given because of the absence

of the authors: Tuesday, June 22, Paper A; Wednesday, June 23, Paper B, Paper M6, Paper M8; Thursday, June 24, Papers M10, M11, and M12.

Business Meeting, June 23, 1943: Chairman R. Whitaker presided.

Resolutions: The attached resolution on the necessity of maintaining the quality of ice cream was accepted and referred to the General Committee.

Special Committee: It was suggested by K. G. Weckel that the American Dairy Science Association approve a resolution in honor of S. M. Babcock. The motion was duly seconded and approved. Chairman Whitaker then appointed K. G. Weckel to prepare a suitable statement for further consideration.

Report of Committee on Election of Officers by Ballot: Nothing to report.

Report of Ice Cream Committee: Chairman P. H. Tracy reported for the General Ice Cream Committee and the following sub-committee reports were accepted:

1. Reconsideration of mix composition in light of the shortage of mix solids and the possibility of rationing. Reported by W. H. E. Reid.
2. Modification of chocolate coating formulas so as to minimize the amount of cocoa or chocolate used. Reported by J. H. Erb.
3. Manufacture of a satisfactory bar coating using flavors other than chocolate. Reported by C. A. Iverson in the absence of P. S. Lucas.
4. The part that ice cream can play in a war economy. No report.

Report of Cheese Committee: W. V. Price presented the attached progress report which was accepted.

Report of By-products Committee: The attached report on by-products was read by B. H. Webb and was accepted.

Report of Products Judging Committee: Chairman G. M. Trout submitted the attached report which was accepted.

Report of Evaporated Milk Committee: The attached evaporated milk report was read by J. H. Erb and was accepted.

Special Committee: Chairman R. Whitaker appointed O. F. Garrett and P. H. Tracy to carry the best wishes of the Manufacturing Section to one of our hosts, E. R. Garrison, who is in the hospital due to a recent accident.

Nominating Committee: R. Whitaker appointed the following committee to nominate officers for the Manufacturing Section: C. W. England, chairman, M. W. Yale, H. L. Templeton.

Business Meeting, Thursday, June 24, 1943: Chairman R. Whitaker presided.

Report of Nominating Committee and Election of Officers: Chairman C. W. England of the Nominating Committee read the report and it was accepted. L. K. Crowe was elected as vice-chairman of the Manufacturing Section and I. A. Gould was elected as secretary of the Manufacturing Section. Vice-chairman Paul F. Sharp automatically becomes chairman of the Manufacturing Section for the coming year.

Resolutions: Two resolutions were approved and referred to the General Resolutions Committee.

Report of Butter Committee: No report.

Report of Dried Milk Committee: G. E. Holm read the attached report of the committee and it was accepted.

Report of Milk Committee: The attached report of the Milk Committee was read by H. L. Templeton. It was accepted.

The Manufacturing Section held joint session Thursday afternoon, June 24, on "The Utilization of the Milk Supply" in cooperation with the Extension and Production Sections.

The Manufacturing Section adjourned June 24, 1943.

PRODUCTION SECTION

Secretary G. W. Salisbury of the Production Section then gave the following report. He moved and W. W. Yapp seconded that the report be accepted.

The Production Section held two joint meetings with the Extension Section and one with the Extension and Manufacturing Sections. In the joint meetings with the Extension Section particular attention was paid to the wartime dairy cattle feeding and breeding problems.

On Wednesday, June 23, papers of special interest relating to timely research now being conducted at the various stations were presented in two simultaneous sessions of the Section. These sessions were presided over by K. L. Turk and Dwight Espe, chairman and vice-chairman, respectively, of the Production Section. Of the thirty-six papers listed in the program for the meeting, 35 were presented.

The Section held two business meetings, at each of which K. L. Turk presided. At the first meeting consideration was given to the report of the Special Committee on The Feed Situation as Related to Milk Production. After due deliberation and after certain constructive suggestions were incorporated, the Section approved the report of this Special Committee.

Reports from the various standing committees were presented. Copies of these reports are attached. Salient points incorporated in these reports are presented herewith for approval.

The Breeds Relations Committee (Joint with Extension Section): The Section has approved the following recommendations of this committee:

1. The Uniform Dairy Bull Score card which has been adopted by the dairy breed associations be approved and adopted by the American Dairy Science Association.

2. The Purebred Dairy Cattle Association be asked to take over the printing and distribution of the uniform forms for reporting official tests.

3. The labor-saving type of form for the Herd Improvement Registry reports designed by the Holstein-Friesian Association of America be approved for trial in some of the larger herds.

4. That there be selected two members of the Breeds Relations Committee who shall constitute official representation of the American Dairy Science Association at meetings of the Purebred Dairy Cattle Association, and that they consist of a member of the Extension Section and the Production Section.

Dairy Cattle Breeding Committee (Joint with Extension Section): The committee offered recommendations pertaining to the proving of sires which were approved by the Production Section. These recommendations were as follows:

1. That herd averages of all stall-mates of the daughters be included in each proved sire report in order to give additional information helpful in evaluating sires.

2. That within the various states, more use be made of partial lactation records (three or four months in length) in locating bulls for more extensive service.

3. That we commend the action of the Purebred Dairy Cattle Association for developing and recommending to its member breed associations a uniform basis for the evaluation of sires and dams utilizing all records on a 305 day, twice-a-day milking mature equivalent basis.

Suggestions were approved for safeguarding the registration of purebred animals resulting from artificial insemination.

Measuring Results of Pasture Investigations: The committee report was accepted, including a recommendation that the present name of the committee be changed to the Pasture and Roughage Committee, and that its scope be expanded to include study and recommendations in cooperation with the Extension Section, on increasing pasture production in all forms under war conditions.

No reports were submitted by the following committees:

1. Feed Specifications.
2. Silage Methods and Evaluations.
3. Awards for the Students' National Contest in Judging Dairy Cattle.
4. Rules for Conduct of Students' National Dairy Cattle Judging Contest.

The Section voted to temporarily dispense with the committees on Awards for Students' National Contest in Judging Dairy Cattle and on Rules for Conduct of Students' National Dairy Cattle Judging Contest, but that a chairman of each of these committees be continued with power to act when the contests are resumed.

Nominating Committee: Report of the committee was read and approved. G. W. Salisbury (Cornell) was elected vice-chairman, and D. M. Seath (Louisiana) was elected secretary. Dwight Espe (Iowa), the present vice-chairman, automatically becomes chairman of the Production Section for the ensuing year.

EXTENSION SECTION

Acting Secretary Floyd Arnold then gave the following report. Upon motion duly seconded it was adopted.

The Extension Section has enjoyed and profited much by three full days of meetings here at the University of Missouri. The attendance at the different sessions averaged slightly less than in some of our former meetings but sixteen states were represented.

As scheduled two joint sessions were held with the production section. The first session was presided over by K. L. Turk, Chairman of the Production Section, and dealt with War-time problems in dairy cattle feeding. The second session was presided over by Warren Gifford and dealt with dairy cattle breeding.

A joint session with both the production and manufacturing sections was also held as scheduled and the papers presented dealt with the utilization of the milk supply.

On Wednesday, June 23, both sessions of the Extension Section were given to reports of committees. Chairman J. F. Kendrick called for the reports in order. The section has ten standing committees and each year a major portion of the program is developed around the work of one or more of the committees. This year the Testing and Dairy Cattle Breeding Committees were given special attention.

1. *Testing:* The report of the testing committee was presented by a six-member panel and "Wartime D.H.I.A. Adjustments" were considered. The recommendations of the committee were accepted.

2. *Dairy Cattle Breeding:* The Dairy Cattle Breeding Committee report was presented by E. J. Perry. Three papers were read. The Committee offered recommendations pertaining to the proving of sires. The recommendations had been agreed upon by a joint committee of Production and Extension Sections. They were approved. The committee in collaboration with breed association representatives had also drawn up rules for safeguarding the accuracy of the registration of pure bred animals resulting from artificial insemination. These rules were approved. A copy of the recommendations and rules are attached.

3. *Exhibits:* Twelve states brought exhibits of methods and ideas to the meeting. The committee recommended that the practice be continued at future anual meetings. If no annual meeting is held, the committee recommended that a list of new material being used by the extension dairymen of the various states be obtained and distributed so that those interested can obtain copies by request. The recommendation was approved.

4. *Type rating:* E. C. Scheidenhelm reported for the type rating committee and said that the form and procedure set up in 1941 had been used by two states. No changes were suggested. The report was accepted.

5. *Breeds Relation:* The breeds relations committee reported on its work during the past year and presented four recommendations which had been

drawn up by the joint committee of the Production and Extension Sections. The recommendations were approved.

6. *Dairy Farm Management:* The dairy farm management committee presented a simplified record form and urged the different states to try it. The report was accepted.

A major portion of the business of the section was transacted at the 11 A.M. session on Thursday.

The Resolutions Committee report was read and approved.

The final order of business was the election of an incoming secretary and a vice-chairman to fill the vacancy of G. G. Gibson. Gerald Heebink, West Virginia, was elected secretary and Floyd Arnold, Iowa, was elected vice-chairman. The chairman of the new year is E. C. Scheidenhelm of Michigan.

EDITOR'S REPORT

The Editor begs to submit the following brief report to the Officers and the Board of Directors of the Association:

1. *Summary of Journal Contents:* A summary of the Journal contents over the past four years is presented in the accompanying table.

The figures presented in this table for 1939–40 and 1940–41 represent 11 issues of the Journal, the June issue not being included. The figures for 1941–42 and 1942–43 include 12 issues, that is, July through June, inclusive, each year.

You will note that the total number of pages has decreased slightly in 1942–43, and in all probability there will be a further decrease during the next year.

SUMMARY OF JOURNAL CONTENTS

	1939–40	1940–41	1941–42	1942–43
Number of original articles	94	97	101	89
Pages of original articles	826	892	938	788
Number of reviews	3	5	3	2
Pages of reviews	119	144	80	142
Miscellaneous	98	157	106	192
Students National Contest, Proceedings Annual Meeting, Announcements, Circulation, Index, Committee Reports				
Pages of Abstracts	206	304	418	290
Total number of pages printed	1245	1497	1542	1412
Classification of Articles				
Manufacturing articles	53	56	59	50
Pages occupied by Manufacturing	450	514	548	414
Production articles	31	35	36	32
Pages occupied by Production	296	316	336	314
Manufacturing-Production	10	6	6	7
Pages occupied	80	62	54	60

Classification Reviews			
Manufacturing reviews	5	1	1
Pages occupied by Manufacturing Reviews	144	36	86
Production reviews		2	1
Pages occupied by Production Reviews		44	56

2. *Papers on Hand:* We have not experienced as great a decrease in the number of papers submitted as was anticipated one year ago. A sufficient numbers of papers are on hand assuring a normal size journal for the remainder of 1943.

During the first five months of 1943, 42 papers were submitted for publication. During the corresponding period in 1942, 52 papers were submitted. Assuming about the same number of rejections, we have about ten fewer papers on hand than we had this time last year. During the past two months, however, papers have not been received in the customary number of past years. April and May are usually heavy months because of graduate students finishing their work and of authors preparing papers for the Annual Meeting, etc.

3. *Abstracts:* The total number of pages of abstracts has fallen off somewhat. However, I believe this is partly due to a little finer sifting as well as fewer articles of interest published in the journals which we cover.

4. *Publication of Committee Reports:* Inasmuch as no definite policy has been established regarding the routine in which committee reports should be handled, we suggest that this matter be considered by the Board of Directors at the present meeting.

5. *Acknowledgment:* The Editor wishes to publicly express his deep gratitude to all of those who have so generously assisted in the editorial work of our Journal. Credit for any measure of success attained is due to those who have so willingly given of their time and energies.

To those who have contributed to our Journal we wish to express our appreciation for their fine spirit of helpful cooperation. Respectfully submitted.

Upon motion duly seconded the report was accepted.

SECRETARY-TREASURER'S REPORT

Membership and Circulation: The total circulation was highest in 1941 when it reached 2447. Last year it decreased about 300, the total circulation being 2143. This was made up of 1276 members, 371 domestic subscribers, 212 foreign subscribers, 49 associate subscribers, and 235 student affiliates.

Our circulation as of June 17, 1943, is 1977 versus 2016 at the same time last year, or a loss of approximately 40. This is not serious when you analyze the different groups. The membership is 1245 versus 1217 for last year. Domestic subscribers are 402 this year versus 351 at the same time

last year. Foreign subscribers are 166 versus 188. Associate subscribers are 64 versus 46 and student affiliates 100 this year versus 214 last year. Our circulation, therefore, is 114 less student affiliates and 23 less foreign subscribers, while all other groups are higher at this time in 1943 than they were on June 17, 1942.

Previous to our charging an affiliation fee, we had much larger turnover in membership. In 1938 we had 332 new members and in 1939 we had 419 new members. In 1940 it was the first year that the $5 affiliation fee went into effect and new members numbered 105, in 1941 they numbered 103, and in 1942 they numbered 100. About 50% of these new members in 1942 paid the $5 affiliation fee and the other 50% were transferred from student affiliates to full-fledged members. Thus far in 1943 we have already had 108 new members, 58 of whom have paid the $5 fee, and 50 of whom have become members by having previously been student affiliates.

We cannot expect to hold our foreign subscribers and student affiliates during the war. Our domestic subscribers at this time for 1943 are 402, which is the highest number of domestic subscribers that the Association has ever had. This is 30 more than the total for the entire year of 1942.

Our total losses in membership amount to from 100 to 150 each year. Our losses are divided into delinquent payment of dues, resignations, and deaths. Our delinquencies in 1940 were 121, in 1941 they were 91, and in 1942 they were 88. At the present time there are 108 delinquents, but this will probably be reduced to 60 or 75 before the end of the year. Our resignations were highest in 1942, there being 62. This year they are only 45. If the average annual total loss is to be from 100 to 150 each year, the remedy for our holding a steady circulation or increasing it is to have a continuous program of obtaining new members.

New Members: We should have 150 new members annually, which would be more than 10% of our present membership. If this gain were divided up equally among states, it would not be a difficult task. A state that has 10 members would be obligated to get one new member each year. Illinois with a membership of 114, they lead in membership, would be asked to obtain 11 new members each year, a part of which would come from student affiliates and a part from those paying the affiliation fee.

Of the 108 new members that we have had this year, they are from 38 States and Canada. Arizona, Arkansas, Washington, D. C., Georgia, Iowa, Kansas, Maine, New Hampshire, New Jersey, Utah, Virginia, and Canada have furnished one each; Florida, Louisiana, Michigan, Minnesota, and West Virginia have 2 each; Colorado, Maryland, Texas, and Washington have 3 each; Missouri and Oregon have 4 each; Connecticut, 5; California, 6; Indiana, 7; Illinois, Pennsylvania, and Wisconsin tied for third place with 8 each; New York is second with 10; and Ohio is first with 14.

The problem of this Association is how we can retain the interest of dairy trained men in the applied science of dairying. It is a shocking fact that

we have mentally fit men in the field of education, extension, and research in the dairy industry who do not have sufficient interest in their work to contribute $5 per year to keep up their membership in this Association. Perhaps the articles are not written properly or they may be too scientific, but we must remember that all phases of the dairy industry are more scientific today than they were 20 years ago. It is our responsibility to find reasons why our Association does not appeal to all men who are giving their life to this profession, and it is our job to sell our students on the need of keeping up with new things by reading the Journal, after they have graduated from the institution.

Interests of Our Membership: In order to determine the approximate percentage of our membership interested in the different fields of dairying, a survey was made of all the members and it was found that their interests and occupations were as follows:

Teaching manufacturing subjects	13.8%
Teaching dairy husbandry	16.5%
Commercial manufacturing	39.3%
Commercial production	7.2%
Extension, commercial and teaching	7.0%
Health officers, agricultural commissioners, etc.	6.2%
Unknown by analyst	10.0%
	100.0%

Back Copies: This past year our income from back copies is lower than it has been since 1937. We received $358.58 for back copies while previous years we have received about $500. Your management thought that the 20-Year Index would stimulate the ordering of back volumes. As yet this has not occurred. We again suggest that you check your libraries and if any volumes are missing, that you have them order the complete volume because they are now available from Volume I to XXV, inclusive.

20-Year Index: The total cost of publishing 1,000 paper bound and 1,000 cloth bound copies of the 20-Year Index amounted to $3,994.44. Up to June 17, 1943, we have sold 710 paper bound copies and 370 cloth bound copies.

The total income is $1,567.65, which will be a net loss of $1,909.99 when the inventory of $516.80 is subtracted from the loss. Your Board of Directors estimated that this loss would amount to $2,000 when the prices for the Index were established.

Advertising: The report for advertising is very bright. In 1938 we sold 93¾ pages; in 1939, 124 pages; 1940, 126½ pages; 1941, 140¾ pages; and 1942, 143¾ pages. The first half of 1943 we have sold 81½ pages which is more than we have ever sold in the first six months of the year, and indicates that we'll have more advertising during this year than ever before. We are most grateful for those companies that use our pages for advertising. Any courtesies shown these advertisers will be appreciated.

Financial: Our income for 1942 is the largest income of any year during our organization with $18,525.01. Our expenditures were also higher than they have ever been before and were $19,577.21. We have a total operating loss of $1,052.20. This loss was due, of course, to the expenditure made for the 20-Year Index. Our net worth is $19,547.91. We have an investment in government bonds of $19,470. A complete report of the Certified Public Accountant was sent to each Director and Officer in March of this year.

During the year 1942 we had 2500 Journals printed per month. In February we had 3500 printed, and beginning with March we are having 2300 Journals printed per month.

Upon motion duly seconded the Secretary's report was accepted.

The Secretary then read the minutes of the Board of Directors meetings. They will be found following the minutes of this meeting.

A motion was made and seconded that the minutes of the Board of Directors be accepted, and that all action taken by the Board of Directors during the past year be approved and endorsed by the Association. Motion carried.

The report of the Auditing Committee was read and is as follows:

To the Members of the American Dairy Science Association

Gentlemen:

Mr. Walter Burnham of Columbus, Ohio, Certified Public Accountant, has made an audit and report of the financial condition of the Association.

The Auditing Committee has conferred with Mr. Burnham and is satisfied that he had made a careful examination of all assets and liabilities of the Association and that all the acounts are accurate. The committee is satisfied that the balance sheet and related summary of profit and loss represents the financial condition of the American Dairy Science Association.

Upon motion duly seconded the report was accepted.

Professor G. M. Trout then read a brief history of the American Dairy Science Association. R. B. Stoltz moved and A. A. Borland seconded that this report be accepted and published in the JOURNAL OF DAIRY SCIENCE. The report is as follows:

HISTORY OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

The organization which is now known as the American Dairy Science Association was organized July 17, 1906, as the National Association of Dairy Instructors and Investigators. The first meeting was held at the University of Illinois, Urbana, Illinois, with W. J. Fraser as chairman and C. B. Lane as secretary. At this meeting R. A. Pearson was elected president, Oscar Erf, vice-president, and C. B. Lane, secretary of the organization for the first year. The proceedings and program of this meeting were published as Illinois Agricultural Experiment Station Circular No. 111, 1907. This 60-page report includes the names of the charter and new members, committee appointees and papers presented.

The names of the early committees are of interest. There were seven in number as follows:

"Score Card for the Registration of Dairies"

"Official Testing of Dairy Cows"

"Our Relations to the National Dairy Show"

"Courses of Instruction"

"Experimental Work—Production"

"Experimental Work—Manufacture"

"Membership"

The papers presented at the first meeting and published in Illinois Agricultural Experiment Station Circular No. 111 are as follows:

"The Manufacture of Condensed Milk," O. F. Hunziker, Purdue University.

"A Plan for the Registration of Dairies, Leading to the Improvement of Market Milk," C. B. Lane, Asst. Chief Dairy Div., U. S. Dept. Agr.

"City Milk Supply," J. M. Trueman, University of Illinois.

"Some Hand Separator Problems," C. H. Eckles, University of Missouri.

"Pasteurization of Hand Separator Cream for Making Butter," C. E. Lee, University of Illinois.

"Milking Machines," H. H. Dean, Ontario Agricultural College, Guelph.

"Advantages of the Organization of Dairy Instructors and Investigators," E. H. Webster, Chief Dairy Division, U. S. Dept. Agr.

"Opportunities for Research Work in the Manufacture of Dairy Products," C. F. Doane, Dairy Division, U. S. Dept. Agr.

"How Shall We Conduct Feeding Experiments with Dairy Cows?" B. E. Carmichael, Ohio Experiment Station.

"Dairy Instruction," H. E. Van Norman, Pennsylvania State College.

"Soft Cheese Problems," Charles Thom, Dairy Division, U. S. Dept. Agr.

"Reaching the Farmer," E. S. Guthrie, Ohio State University.

"Testing Dairy Herds," H. A. Hopper, University of Illinois.

Professor W. J. Fraser of Illinois took the initiative in forming this Association. Meeting yearly, usually in connection with the National Dairy Show, the organization continued under its original name until 1917 when by an overwhelming ballot the "Official Dairy Instructors Association" became the American Dairy Science Association.

To date, 38 annual meetings of the Association have been held as indicated in table 1. The first summer meeting was held at the Michigan State College in 1927. Since then the annual meetings have been held during early summer at one or more of the Agricultural Colleges and Experiment Stations or at the United States Department of Agriculture, Washington, D. C. Apparently the advent of the summer meetings marks the beginning

TABLE 1

The officers of the American Dairy Science Association by years

Meeting	Location of annual meeting	Date	President	Vice-President	Secretary-Treasurer
1st	Urbana, Ill.	1906	R. A. Pearson	Oscar Erf	C. B. Lane
2nd	Chicago, Ill.	1907	"	"	"
3rd	Ithaca, N. Y.	1908	C. H. Eckles	H. E. Van-Norman	"
4th	Milwaukee, Wis.	1909	"	"	"
5th	Chicago, Ill.	1910	O. F. Hunziker	W. J. Fraser	W. A. Stocking
6th	" "	1911	"	"	"
7th	" "	1912	J. H. Frandsen	F. Rasmussen	"
8th	" "	1913	"	"	C. W. Larson
9th	" "	1914	F. Rasmussen	W. A. Stocking	"
10th	San Francisco, Cal.	1915	"	(unofficial meeting)	
11th	Springfield, Mass.	1916	W. A. Stocking	A. C. Anderson	M. Mortensen
12th	Columbus, Ohio	1917	"	"	"
13th	"	1918	A. C. Anderson	M. Mortensen	N. W. Hepburn
14th	Chicago, Ill.	1919	"	"	"
15th	" "	1920	M. Mortensen	O. E. Reed	"
16th	St. Paul, Minn.	1921	C. H. Eckles	"	"
17th	" " "	1922	"	A. A. Borland	J. B. Fitch
18th	Syracuse, N. Y.	1923	A. A. Borland	O. E. Reed	"
19th	Milwaukee, Wis.	1924	"	"	"
20th	Indianapolis, Ind.	1925	O. E. Reed	H. F. Judkins	"
21st	Detroit, Mich.	1926	"	"	G. C. White
22nd	East Lansing, Mich.	1927	J. B. Fitch	J. M. Sherman	"
23rd	Madsion, Wis.	1928	G. C. White	A. C. Baer	J. M. Sherman
24th	Washington, D. C.	1929	"	H. A. Ruehe	"
25th	Ames, Iowa	1930	J. M. Sherman	H. C. Jackson	R. R. Graves
26th	Berkeley-Davis Cal.	1931	H. B. Ellenberger	C. E. Wylie	"
27th	Lexington, Ky.	1932	E. L. Anthony	R. B. Stoltz	"
28th	Urbana, Ill.	1933	H. C. Jackson	"	"
29th	Ithaca-Geneva, N. Y.	1934	R. B. Stoltz	C. L. Roadhouse	"
30th	St. Paul, Minn.	1935	C. L. Roadhouse	H. A. Ruehe	"
31st	State College, Pa.	1936	H. A. Ruehe	R. R. Graves	R. B. Stoltz
32nd	Lincoln, Neb.	1937	R. R. Graves	H. W. Gregory	"
33rd	Columbus-Wooster, O.	1938	H. W. Gregory	E. Weaver	"
34th	Moscow, Id. & Pullman, Wash.	1939	E. Weaver	E. S. Guthrie	"
35th	W. Lafayette, Ind.	1940	E. S. Guthrie	H. W. Cave	"
36th	Burlington, Vt.	1941	H. W. Cave	H. F. Judkins	"
37th	East Lansing, Mich.	1942	H. F. Judkins	H. P. Davis	"
38th	Columbia, Mo.	1943	H. P. Davis	A. C. Dahlberg	"

of a period of rapid growth in attendance. Professor Hayden, charter member, writes in part, "My memory is that those early meetings held at the National Dairy Show were not very well attended (except the banquet) and the attendance was irregular. Often interest in some event at the show would almost break up the meeting. The early meetings were largely taken up by committee reports. The Association really began to grow when the meetings were changed from the National Dairy Show to midsummer."

TABLE 2

The directors of the American Dairy Science Association

1933	*1934*	*1935*
E. Weaver	E. Weaver	M. Mortensen
O. F. Hunziker	O. F. Hunziker	O. F. Hunziker
L. A. Rogers	L. A. Rogers	L. A. Rogers
1936	*1937*	*1938*
M. Mortensen	E. G. Hood	E. V. Ellington
C. R. Gearhart	E. Weaver	H. Macy
L. A. Rogers	M. Mortensen	E. G. Hood
	J. A. Nelson	C. E. Wylie
	C. R. Gearhart	C. R. Gearhart
	H. P. Davis	J. A. Nelson
	H. A. Ruehe	R. R. Graves
1939	*1940*	*1941*
J. W. Linn	C. N. Shepardson	H. B. Ellenberger
M. E. Parker	F. Ely	A. C. Dahlberg
E. V. Ellington	J. W. Linn	C. N. Shepardson
H. Macy	M. E. Parker	F. Ely
E. G. Hood	E. V. Ellington	J. W. Linn
C. E. Wylie	Harold Macy	M. E. Parker
H. W. Gregory	Earl Weaver	E. S. Guthrie
1942	*1943*	
G. M. Trout	R. B. Becker	
J. C. Knott	W. E. Petersen	
H. B. Ellenberger	G. M. Trout	
A. C. Dahlberg	J. C. Knott	
C. N. Shepardson	H. B. Ellenberger	
F. Ely	C. R. Gearhart	
H. W. Cave	H. F. Judkins	

Professor Fraser, charter member, states also in part concerning the early meetings, "We had a banquet and started the program right at the table as soon as we were through eating. These annual meetings were taken up largely by reports of committees. These meetings were of course short and after much discussion by some of us to have longer meetings during the summer vacation this method was finally adopted."

The wisdom in adopting summer meetings is shown by the records of attendance which reached a peak of 844 at the Vermont summer meeting in 1941.

Officers of the Association: W. J. Fraser was chairman of the organization meeting in 1906 at which R. A. Pearson was elected the first president. His tenure of office was for two years. With few exceptions up to 1930,

when the tenure of office became one year, the presidents served a two-year period. W. A. Stocking served the longest continuous priod, three years, from 1916 to 1918, inclusive. C. H. Eckles, who followed Pearson as president during 1908 and 1909, again served the Association as president in 1921 and 1922, a total of four years which was the longest service as president given by any one man. In all, the Association has had 26 presidents as shown in table 1. Ten secretary-treasurers have served the Association. C. B. Lane was the first secretary-treasurer, serving four years. Since then nine others have served the Association in that capacity; the present incumbent, R. B. Stoltz, having the longest tenure of office, eight years.

A Board of Directors consisting of three members serving one, two, and three years respectively was elected in 1933 and each year following. In

TABLE 3

Section officers of the American Dairy Science Association

Year	Chairman	Vice-Chairman	Secretary
	Official Testing and Advanced Registry		
1920–1921	H. P. Davis		M. H. Fohrman
1921–1922	H. P. Davis		M. H. Fohrman
1922–1923	H. P. Davis	L. H. Fairchild	R. T. Harris
1923–1924	R. T. Harris		G. C. White
1924–1925	R. T. Harris		G. C. White
1925–1926	G. C. White		C. E. Wylie
1926–1927	C. E. Wylie		W. E. Petersen
1927–1928	P. S. Williams		J. M. Fuller
1928–1929	A. C. Ragsdale		G. E. Taylor
1929–1930	A. C. Ragsdale		G. E. Taylor
1930–1931	E. L. Anthony		P. C. McGilliard
1931–1932	E. L. Anthony		P. C. McGilliard
1932–1943		(No officers listed)	
	Production		
1920–1921	W. M. Regan		P. S. Williams
1921–1922	W. M. Regan	A. C. Ragsdale	E. L. Anthony
1922–1923	O. E. Reed		A. B. Rayburn
1923–1924	J. J. Hooper		J. A. Gamble
1924–1925	J. A. Gamble		J. P. LaMaster
1925–1926	C. C. Hayden		O. G. Schaefer
1926–1927	A. C. Ragsdale		H. W. Cave
1927–1928	E. L. Anthony		C. F. Huffman
1928–1929	Fordyce Ely		R. B. Becker
1929–1930	H. B. Ellenberger		C. W. Turner
1930–1931	P. M. Brandt		W. B. Nevens
1931–1932	G. Bohstedt		T. W. Gullickson
1932–1933	J. H. Hilton		S. M. Salisbury
1933–1934	H. O. Henderson		C. Y. Cannon
1934–1935	C. Y. Cannon		R. H. Lush
1935–1936	K. S. Morrow		W. E. Krauss
1936–1937	F. W. Atkeson	W. E. Krauss	I. W. Rupel
1937–1938	W. E. Krauss	W. H. Cave	I. R. Jones
1938–1939	W. H. Cave	A. H. Kuhlman	A. L. Beam
1939–1940	A. H. Kuhlman	W. E. Petersen	H. A. Herman
1940–1941	W. E. Petersen	H. A. Herman	K. S. Morrow
1941–1942	H. A. Herman	K. L. Turk	D. L. Espe
1942–1943	K. L. Turk	D. L. Espe	G. W. Salisbury

TABLE 3 (*Continued*)

Year	Chairman	Vice-Chairman	Secretary
		MANUFACTURING	
1920–1921	Roy Potts	W. P. B. Lockwood	A. W. Rudnick
1921–1922	L. A. Rogers	C. L. Roadhouse	H. A. Ruehe
1922–1923	H. A. Ruehe		J. R. Kiethley
1923–1924	H. W. Gregory		R. C. Fisher
1924–1925	H. F. Judkins		N. E. Olson
1925–1926	A. C. Baer		C. D. Dahle
1926–1927	E. S. Guthrie		W. H. E. Reid
1927–1928	W. V. Price		P. S. Lucas
1928–1929	W. H. Martin		J. C. Hening
1929–1930	C. L. Roadhouse		C. D. Dahle
1930–1931	C. L. Roadhouse		A. O. Dahlberg
1931–1932	R. B. Stoltz		E. G. Hood
1932–1933	J. O. Barkman		P. H. Tracy
1933–1934	H. Macy		J. H. Erb
1934–1935	M. J. Mack		G. M. Trout
1935–1936	L. M. Thurston		W. V. Price
1936–1937	P. H. Tracy		J. C. Marquardt
1937–1938	C. J. Babcock		B. E. Horrall
1938–1939	P. A. Downs	F. H. Herzer	J. I. Keith
1939–1940	F. H. Herzer	C. D. Dahle	S. T. Coulter
1940–1941	C. D. Dahle	L. H. Burgwald	E. O. Anderson
1941–1942	L. H. Burgwald	R. Whitaker	K. G. Weckel
1942–1943	R. Whitaker	P. F. Sharp	R. J. Ramsey
		EXTENSION	
1921–1922	E. M. Harmon	C. A. Hutton	C. R. George
1922–1923	E. M. Harmon		A. J. Cramer
1923–1924	L. W. Morley		C. A. Hutton
1924–1925	L. W. Morley		C. A. Hutton
1925–1926	A. J. Cramer		C. R. Gearhart
1926–1927	A. J. Cramer		C. R. Gearhart
1927–1928	G. A. Williams		A. C. Baltzer
1928–1929	G. A. Williams		A. C. Baltzer
1929–1930	G. A. Williams		A. C. Baltzer
1930–1931	M. J. Regan	G. E. Gordon	M. L. Black
1931–1932	M. J. Regan	M. L. Flack	C. R. Gearhart
1932–1933	C. R. Gearhart		Floyd Johnston
1933–1934	J. W. Linn		C. L. Blackman
1934–1935	F. Johnston		C. L. Blackman
1935–1936	E. J. Perry		Earl N. Shultz
1936–1937	C. L. Blackman	E. N. Shultz	S. J. Brownell
1937–1938	E. N. Shultz	S. J. Brownell	R. G. Connelly
1938–1939	S. J. Brownell	R. G. Connelly	O. J. Hill
1939–1940	R. G. Connelly	O. J. Hill	G. W. Vergeront
1940–1941	O. J. Hill	G. W. Vergeront	J. F. Kendrick
1941–1942	G. W. Vergeront	J. F. Kendrick	E. C. Scheidenhelm
1942–1943	J. F. Kendrick	E. C. Scheidenhelm	G. G. Gibson
		ECONOMICS	
1930–1931	F. A. Buechel		Roy C. Potts
1931–1932	F. A. Buechel		Roy C. Potts
1932–1933	F. A. Buechel		Roy C. Potts
1933–1934	F. A. Buechel		Roy C. Potts
1934–1943		(No officers listed)	

1937, the number of directors was increased to seven of which six were elected as such, while the seventh consisted of the retiring president. The names of the directors are presented in table 2.

Sections of the Association: Professor Mortensen, in his presidential address October 11, 1920, strongly advised that the annual meetings of the

TABLE 4

The officers of the Eastern, Southern, and Western Divisions of the American Dairy Science Association

Year	Chairman	Vice-Chairman	Secretary-Treasurer
		EASTERN	
1921–1922	R. C. Fisher		R. W. Smith, Jr.
1922–1923	R. C. Fisher	A. A. Borland	R. W. Smith, Jr.
1923–1924	R. C. Fisher	A. A. Borland	R. W. Smith, Jr.
1924–1925	A. A. Borland	H. B. Ellenberger	R. W. Smith, Jr.
1925–1926	H. B. Ellenberger	G. C. White	A. L. Beam
1926–1927	J. M. Fuller	S. I. Bechdel	S. H. Harvey
1927–1928	H. F. DePew	M. H. Campbell	M. J. Mack
1928–1929	C. L. Allen	R. W. Smith, Jr.	M. J. Mack
1929–1930	E. O. Anderson	C. D. Dahle	C. B. Bender
1930–1931	A. L. Beam	P. F. Sharp	C. B. Bender
1931–1932	E. S. Guthrie	C. B. Bender	R. E. Johnson
1932–1933	C. B. Bender	F. J. Doan	R. E. Johnson
1933–1934	R. W. Smith, Jr.	R. E. Johnson	H. G. Lindquist
1934–1935	R. E. Johnson	M. J. Mack	H. G. Lindquist
1935–1936	M. J. Mack	M. H. Campbell	J. A. Newlander
1936–1937	A. R. Merrill	H. G. Lindquist	F. J. Doan
1937–1938	H. G. Lindquist	M. H. Campbell	H. C. Moore
1938–1939	M. H. Campbell	F. J. Doan	H. C. Moore
1939–1940	F. J. Doan	K. S. Morrow	H. C. Moore
1940–1941	K. S. Morrow	H. C. Moore	L. R. Dowd
1941–1942	H. C. Moore	A. I. Mann	L. R. Dowd
1942–1943	H. C. Moore	A. I. Mann	L. R. Dowd
		SOUTHERN	
1922–1923	C. W. Holdaway	C. E. Wylie	J. A. Gamble
1923–1924	C. E. Wylie	J. P. LaMaster	J. A. Gamble
1924–1925	J. P. LaMaster	C. A. Hutton	J. A. Gamble
1925–1926	C. A. Hutton		J. A. Gamble
1926–1927	J. S. Moore		J. P. LaMaster
1927–1928	J. S. Moore		A. C. Baer
1928–1929	A. C. Baer		L. A. Higgins
1929–1930	R. H. Ruffner	L. A. Higgins	J. S. Moore
1930–1931	L. A. Higgins		R. B. Becker
1931–1932	Earl Weaver	R. B. Becker	A. D. Burke
1932–1933	R. B. Becker	A. D. Burke	R. H. Lush
1933–1934	A. D. Burke	R. H. Lush	E. C. Elting
1934–1935	R. H. Lush	E. C. Elting	A. H. Kuhlman
1935–1936	E. C. Elting	A. H. Kuhlman	C. N. Shepardson
1936–1937	A. H. Kuhlman	C. N. Shepardson	T. B. Harrison
1937–1938	C. N. Shepardson	T. B. Harrison	C. G. Cushman
1938–1939	T. B. Harrison	C. G. Cushman	R. E. Waters
1939–1940	C. G. Cushman	R. E. Waters	C. D. Grinnels
1940–1941	R. E. Waters	C. D. Grinnels	R. B. Becker
1941–1942	C. D. Grinnels	R. B. Becker	J. P. LaMaster
1942–1943	R. B. Becker	J. P. LaMaster	F. H. Herzer

TABLE 4 (*Continued*)

Year	Chairman	Vice-Chairman	Secretary-Treasurer
		WESTERN	
1923–1924	W. M. Regan	A. H. Rishoi	R. C. Jones
1924–1925	H. A. Bendixen		N. C. Jamison
1925–1926	E. V. Ellington		N. C. Jamison
1926–1927	F. W. Atkeson		N. C. Jamison
1927–1928	G. D. Turnbow		J. C. Knott
1928–1929	N. C. Jamison		J. C. Knott
1929–1930	N. C. Jamison		J. C. Knott
1930–1931	I. R. Jones		D. R. Theophilus
1931–1932	D. R. Theophilus		R. W. Morse
1932–1933	G. H. Wilster		R. W. Morse
1933–1934	R. W. Morse		R. E. Hodgson
1934–1935	J. A. Nelson		O. J. Hill
1935–1936	J. A. Nelson		O. J. Hill
1936–1937	O. J. Hill	J. Berry	D. L. Fourt
1937–1938	A. J. Morris	Ivan H. Loughary	D. L. Fourt
1938–1939	I. H. Loughary	G. A. Richardson	J. O. Tretsven
1939–1940	G. A. Richardson	D. L. Fourt	J. O. Tretsven
1940–1941	D. L. Fourt	N. S. Golding	H. P. Ewalt
1941–1942	N. S. Golding	S. W. Mead	H. P. Ewalt
1942–1943	N. S. Golding	S. W. Mead	H. P. Ewalt

Association be held in sections as follows: (1) Relation to breed associations, (2) dairy production, (3) dairy manufacturing, and (4) extension workers. During the years which have followed five sections have been recognized; official testing and advanced registry, production, manufacturing, extension, and economics. The official testing and advanced registry section and the economics section apparently served the period of their usefulness and no longer appear as separate sections on the program of the annual meetings. The officers of each section are presented in table 3.

Division Associations: The revised constitution of the American Dairy Science Association, 1922, provided for the organization of divisions of the Society based upon geographical considerations. In due time, therefore, the Eastern, Southern, and Western Divisions of the American Dairy Science Association were approved. The officers of these divisions are given in table 4.

Establishment of the Journal: During the first 10 years of the Association, from 1906 to 1916, the organization was without a journal in which to publish its proceedings, papers, reports, etc. As president, J. H. Frandsen in 1913 called attention to the desirability of establishing such a journal. However, it was not until the summer of 1916 that plans were effected for the publication of a bimonthly journal. Consequently, the JOURNAL OF DAIRY SCIENCE made its first appearance in May, 1916. J. H. Frandsen was made editor-in-chief which position he held until 1928 when A. C. Dahlberg became editor. Dahlberg served as editor for the next ten years. In 1938, T. S. Sutton, the present editor, took over the editorship of the Journal.

Summary: A brief sketch of the history and development of the American Dairy Science Association and of its divisions and sections with the officers of each is presented. Frequently, members of nominating committees, especially of sections, are embarrassed and at a loss to know with certainty whom to nominate because they are not familiar with the names of those who have previously served. It is hoped that the lists of officers included herewith might prove helpful to such committees. Furthermore, it is believed that this brief sketch of the Association and its officers might be of value to younger members who are interested in the early history of the Association.

Sources of Material: The sources of material include: (a) Illinois Agricultural Experiment Station Circular 111, 1907, entitled "National Association of Dairy Instructors and Investigators"; (b) correspondence and interviews with charter and early members, with past officers and with the Secretary of the Association; and (c) the minutes, records and reports of the Association as published in volumes 1 to 25, inclusive, of the JOURNAL OF DAIRY SCIENCE. To conserve space, statements in this brief history are not documented.

G. M. TROUT

REPORT OF THE SPECIAL COMMITTEE ON THE FEED SITUATION AS RELATED TO MILK PRODUCTION

Dr. W. E. Krauss then gave the following report. He moved and G. W. Salisbury seconded that it be accepted.

The American Dairy Science Association, while convened at its 38th Annual Meeting at the University of Missouri, Columbia, Missouri, June 22–24, 1943, gave careful consideration to the feed situation as it relates to maximum milk production. It was the opinion of the Association that the Nation faces a serious and critical shortage of human foods and livestock feeds because of the greatly increased food needs for our armed forces, civilian population, our Allies and Lend-Lease and because of the present crop prospects in this country. It was concluded that the shortage of corn in the usual trade channels has created a serious problem with respect to supplying feed for milk production and that the present price relationship between corn and hogs creates a situation that encourages the raising of hogs in excessive numbers and feeding hogs to heavy weights. The price of corn also encourages the feeding of beef cattle for too long a period on corn. Both conditions cause a serious national nutrition problem.

It is further apparent that present price relationships are resulting in a large increase in numbers of poultry and hogs at the expense of the production of milk, which is our most vital food of animal origin and is produced with the highest efficiency among animal food products. The present downward trend in milk production and present crop prospects make the necessity of adjustments a matter of great urgency. It is recommended, there-

fore, that the proper Federal authority make a thorough study of livestock population in relation to the feed supply and human nutritional needs.

The American Dairy Science Association recommends, further, that the Federal government take steps immediately to adjust the factors responsible for this situation, in order that dairy herds may not be deprived of the feeds necessary to secure adequate milk production.

It was also concluded that recommendations concerning most effective feeding and management practices, that would at the same time conserve critical feed nutrients and feeds, be widely disseminated to dairy farmers through all agricultural agencies, including the farm press. The American Dairy Science Association, therefore, pledges its support to the 8-point program of the War Food Administration and the Dairy Industry Committee. The recommendations contained in the 8-point program have been advocated in the past by the American Dairy Science Association and will continue to be advocated as sound dairy practice.

As supplementary to the 8-point program the American Dairy Science Association presents the following feeding, management and feed conservation recommendations:

1. Provide abundant pasture. This reduces labor and allows cows to harvest the crop at its highest feeding value. Use fertilizer on pastures in accordance with state recommendations.

2. Provide as much good hay as possible—either grasses or legumes.

3. Cut early, as hay or silage has the greatest milk producing power at pre-bloom or early bloom according to kind of crop. Where legumes are adapted, they are preferable to grasses.

4. In regions where silage is produced, corn and similar crops should be harvested at the stage of greatest feeding value.

5. Because of the serious protein shortage, no more protein supplement should be used than is required to balance the ration according to the kind of roughage fed. No protein supplement is needed where an abundance of good quality legume roughage is fed along with cereal grains. With hay or silage containing at least $\frac{1}{3}$ legumes, not more than 16% protein is required, and with little or no legumes, not more than 18% protein is needed in the grain mixture.

6. Cows should be fed strictly according to milk production. Rates of feeding grain should vary with quality of the roughage, breed of cattle and other factors. States should develop rules to meet local conditions for their respective states.

7. Since dairy cattle do not require high quality protein, protein supplements should be purchased on the basis of availability and price.

8. Dairy cows do not require a phosphorus supplement when the grain mixture contains at least $\frac{1}{3}$ high protein or $\frac{1}{3}$ wheat milled feeds or a combination. Dairy cows fed legume hay and grain with little or no protein

supplement should receive a phosphorus supplement. Cows on pasture require a phosphorus supplement.

9. Considerable quantities of raw rock phosphate, "colloidal" phosphate, and insufficiently defluorinated phosphates are being moved into feed channels. Because of the danger to dairy cattle of an excessive intake of fluorine, products of this nature should not be used unless they are guaranteed to contain not more than 0.1% fluorine.

10. Every effort should be made to keep the dairy cattle population within limits of the visible feed supply. Culling of inefficient producers should be continued.

11. Advantage should be taken of breeding facilities through artificial breeding and cooperative bull associations that reduce the number of bulls required. This saves feed and labor.

12. Give calves a good early start on milk—then change to a suitable calf meal or calf starter to save whole milk. Start calves on grain and hay not later than two weeks of age.

In view of the shortage of high protein concentrates, The American Dairy Science Association recommends that urea be released by the War Production Board as a source of feed nitrogen for dairy cattle, providing nitrogen from other sources is adequate for fertilizer needs. It recommends also that high protein ingredients be made available to farmers to mix with farm-grown grains, and that they be fed in accordance with the Government and Feed Industry Council protein-conservation program.

It is further believed that the movement of molasses from the West Indies would tend to relieve the shortage of carbohydrate feed for dairy cattle. The American Dairy Science Association recommends that attention be given this problem.

Major C. J. Babcock then presented a report on "Training and Employment of Milk Sanitarians" which is as follows. He moved and L. S. Palmer seconded that the report be accepted.

SUMMARY OF THE REPORT

1. It appears doubtful if there is any wilful discrimination against dairy science graduates on the part of U. S. Public Health Service or State or City Health Departments in the field of milk sanitation.

2. Milk sanitation work in the Army is under supervision of the Veterinary Corps of the Medical Department. It is possible for dairy science graduates to be commissioned in the Sanitary Corps of the Medical Department and to be assigned to the Veterinary Corps for milk sanitation work. It would seem as though this idea should be encouraged. In the Army as well as in civilian life, milk sanitarians should be selected on the basis of their training, experience and administrative ability to do the work at hand.

It is suggested that the Secretary of the American Dairy Science Association might well contact the proper officers in the Medical Department of the Army to see if dairy science graduates might not be assigned in greater numbers to the Veterinary Corps for milk inspection work especially milk processing plant inspection.

3. It would seem that if Heads of Dairy Departments in the various state colleges and universities would maintain an interest in and a close contact with the State and City Health Departments in their respective states that they could render a real service by offering short courses to men already in milk sanitation work and also find it easier to develop and place dairy science graduates with these Health Departments. It is known that a few of the state universities do offer in-service training in the way of short courses.

4. A college degree in some science should be encouraged as a prerequisite for milk sanitation work. The training of men who obtain such degrees might well carry more emphasis on the public health aspects of dairy technology in dairy science courses and public health schools and veterinary school courses might well increase the emphasis on milk sanitation and dairy technology.

5. Courses in Veterinary Science, Sanitary Engineering, Public Health, Dairy Science and Business Administration all have their place in the training of men who expect to make a life work and to rise to the more responsible positions in the milk sanitation field. Such men either before entering the field or perhaps better yet, after getting themselves oriented in the field, should plan to take graduate work covering such phases of the above mentioned training as are not obtained in under-graduate work.

NECROLOGY COMMITTEE REPORT

Mr. Charles Blackman, Chairman of the Necrology Committee, reported the death of the following members during the past year. L. S. Palmer moved and A. A. Borland seconded that the report be accepted.

C. W. Lawrence. C. W. Lawrence, general manager and treasurer of the Miami Valley Milk Producers Association, died October 7, 1942. He was born in the State of Missouri. After he was graduated from Iowa State College, he managed a dairy farm and milk plant at Springfield, Ohio. He later operated his own farm in Clark County and was one of the first men to join the Miami Valley Milk Producers Association. He was elected to the board of directors of that organization in 1922 and in September, 1924, was employed as manager of the Association. He was always active in general farm and cooperative associations, in which he held many positions of responsibility.

Dr. James Marshall Brannon. Dr. Brannon, Assistant Professor and Assistant Chief in Dairy Bacteriology at the University of Illinois College

of Agriculture, died January 21, 1943. Dr. Brannon was born December 14, 1882, at Lowell, Indiana, and was graduated from the University of North Dakota in 1907 with the degree of Bachelor of Arts. He received the Master of Arts degree from the University of Wisconsin in 1914 and the Doctor's degree from Cornell University in 1920. Dr. Brannon taught at the University of North Dakota from 1909 to 1912, at the University of Wisconsin from 1912 to 1915, and at Cornell University from 1915 to 1921. At these institutions he taught Botany, Zoology and Plant Physiology. He served one year on the North Dakota Geological Survey and three years on the North Dakota Biological Survey.

Dr. Brannon was the author of many scientific publications, including "Reports of North Dakota Biological Survey," "Influence of Glucose and Fructose on the Growth of Fungi," "Influence of Certain Sugars on Higher Plants," "Effect of Carbon Dioxide on Bacteria Found in Dairy Products," and "The Effect of Pasteurization Temperature on Bacteria Found in Milk."

Professor E. J. Perry presented a report of the "Activities of The Inter-Association Council on Animal Disease and Production" written by George E. Taylor, representative of the American Dairy Science Association. Upon motion duly seconded the report was accepted.

NOMINATING COMMITTEE REPORT

Mr. M. J. Regan of the Nominating Committee gave the following report. He moved and D. M. Seath seconded that the report be accepted.

For Vice-President: C. N. SHEPARDSON and A. C. RAGSDALE
For Directors: W. H. MARTIN and P. H. TRACY
E. C. SCHEIDENHELM and C. L. BLACKMAN

RESOLUTIONS COMMITTEE

Professor H. W. Cave, Chairman of the Resolutions Committee, submitted the following report. He moved and G. W. Salisbury seconded that the report be accepted.

1. WHEREAS: *our* Association, during this its 38th Annual Meeting, has enjoyed the fine hospitality and facilities of the University of Missouri, and many courtesies from Missouri people and Missouri organizations,

Therefore, be it *Resolved:* That the Secretary of the American Dairy Science Association be instructed to express our appreciation by letter to President Fredrick A. Middlebush and Dean M. F. Miller of the University for the use of its buildings and facilities; to Professor A. C. Ragsdale, his staff and their wives, who have contributed so much effort in planning for our comfort, our meetings, and our entertainment; to Stephens College which has furnished us the use of their beautiful grounds and to the many

Missouri milk and milk products plants, dairy equipment and supply concerns and dairy feed companies that have contributed toward our entertainment.

2. WHEREAS: The Borden Company has again seen fit to offer their awards for outstanding research in dairy production and dairy manufacturing,

Therefore, be it *Resolved:* That the American Dairy Science Association express to them our sincere appreciation of this evidence of their great interest in research which is so vital a part of our industry.

3. WHEREAS: The Purebred Dairy Cattle Association has developed and recommended to its member breed associations a uniform basis for the evaluation of sires and dams, utilizing all records on a 305-day, twice-a-day, milking mature equivalent basis and also have designed an Approved Artificial Breeding Receipt to be used in connection with the registration of calves produced by artificial insemination as carried on by cooperative artificial breeding associations,

Therefore, be it *Resolved:* That the American Dairy Science Association endorse these progressive acts, particularly commend those dairy breed associations which have adopted the recommendations and suggest their serious consideration by the other dairy breed associations and that copies of this resolution be sent to the secretaries of the several dairy cattle breed associations and to the various dairy breed journals.

4. WHEREAS: The several dairy cattle breed associations have made marked progress in unifying their systems of reporting records and in making them available,

Therefore, be it *Resolved:* That these breed associations be commended by the American Dairy Science Association for this action.

5. WHEREAS: Brucellosis in cattle (Bang's disease) causes losses to dairy and beef cattle owners in the United States estimated at $30,000,000 annually, and,

WHEREAS: The losses resulting from sterility, breeding troubles, dead and weak calves and lowered milk yields adversely affect the war effort to produce abundant food, and,

WHEREAS: Sound research accompanied by field trials has demonstrated that calfhood vaccination with strain 19, when applied to calves 4 to 8 months old is a valuable future protection against this disease, and,

WHEREAS: The vaccination of adult cattle with strain 19 (not now publicly advised) might be the means of preventing some of the loss in infected herds where adult cattle not vaccinated as calves are kept with known reactors under a plan of gradual elimination,

Therefore, be it *Resolved:* That the American Dairy Science Association recommend to the National Research Council that further study and research be conducted upon this subject of adult vaccination against brucel-

losis in cattle and that field demonstrations be undertaken similar to those previously sponsored by the U. S. D. A., Bureau of Animal Industry in connection with calfhood vaccination. Also that a copy of this resolution be sent to Dr. John R. Mohler, U. S. D. A., Bureau of Animal Industry, and to Robert F. Griggs, National Research Council, Washington, D. C.

6. WHEREAS: Present restrictions and shortages of dairy products available for ice cream brings up the possibility of producing substandard ice cream, and,

WHEREAS: The members of the American Dairy Science Association are eager to retain the high regard which consumers have come to have for ice cream as a delicious food,

Therefore, be it *Resolved:* That the ice cream industry as a whole and also individual manufacturers strive wherever possible to maintain excellence of quality in ice cream and in any alteration of formulas, that everything possible be done to retain the high position of quality which has been won for ice cream only after many years of effort.

REGISTRATION COMMITTEE REPORT

Professor H. A. Herman, Chairman of the Registration Committee, reported the representation of members as follows:

Arkansas, 3; California, 2; Colorado, 2; Connecticut, 1; Delaware, 1; Florida, 1; Illinois, 47; Indiana, 3; Iowa, 16; Kansas, 6; Kentucky, 3; Louisiana, 2; Maryland, 5; Massachusetts, 5; Michigan, 10; Minnesota, 9; Missouri, 86; Nebraska, 5; New Hampshire, 1; New Jersey, 7; New York, 17; North Carolina, 5; Ohio, 16; Oklahoma, 5; Pennsylvania, 4; South Carolina, 2; South Dakota, 1; Tennessee, 2; Texas, 4; Vermont, 2; Washington, 2; West Virginia, 1; Wisconsin, 27; Washington, D. C., 12, and Canada, 3. This made a total of 318 members registered at the meeting.

Upon motion duly seconded the report was accepted.

The meeting was then adjourned.

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ, *Secretary-Treasurer*

Columbia, Missouri, 9:00 P.M., June 21, 1943

A meeting of the Board of Directors of the American Dairy Science Association was held in the Tiger Hotel, Monday, June 21, 1943, at 9:00 P.M.

Present: President, H. P. Davis; Sec'y-Treas., R. B. Stoltz; Editor, T. S. Sutton; Directors, G. M. Trout, W. E. Petersen, R. B. Becker, C. R. Gearhart. Absent: A. C. Dahlberg, H. B. Ellenberger, J. C. Knott, and H. F. Judkins.

Director Trout moved and Petersen seconded that the minutes of the annual meeting be approved as published in the Proceedings. Motion carried.

Director Petersen moved and Gerhart seconded that the report of the Treasurer as submitted by a Certified Public Accountant to each Director on March 15, 1943, be accepted. Motion carried.

F. B. Morrison, W. E. Krauss, and C. F. Huffman at the invitation of President Davis appeared before the Directors to discuss the Feed Situation.

Upon motion duly seconded the President was authorized to appoint a Special Committee of six to investigate the Milk Production and Feeding Situation and report back to the Association. The Committee consists of the following members: Chairman, W. E. Krauss; F. B. Morrison; C. F. Huffman; R. B. Becker; O. J. Hill; and M. J. Regan.

G. M. Trout, Chairman of the Committee appointed to revise the Constitution and By-Laws, then presented the report of the committee and after some minor changes it was moved and seconded that it be accepted and recommended to the membership as changed. Meeting Adjourned.

Tuesday, June 22, 1943, 4:30 P.M.

Present: Davis, Becker, Gearhart, Petersen, Stoltz, Sutton, Trout, and C. J. Babcock. Editor Sutton then presented his report and by motion of Director Petersen seconded by Director Gearhart the report was accepted.

Major C. J. Babcock reported for the committee that had been appointed to investigate the Training and Employment of Milk Sanitarians. Stoltz moved and Petersen seconded that Major Babcock be requested to present this report at the general Association meeting and that the President be authorized to appoint a committee to study these problems and report back at our next annual meeting.

The report of the Journal Management Committee was received and upon motion duly seconded was accepted. The Secretary then read his report and upon motion duly made and seconded it was accepted.

The budget which has been submitted to each director and officer the earlier part of June was discussed and upon motion duly seconded it was adopted for the year 1944. Adjournment.

Wednesday, June 23, 1943, 12:15 P.M.

Present: Davis, Trout, Becker, Gearhart, Petersen, Sutton, and Stoltz.

Petersen moved and Becker seconded that in order to have committee reports published they must have the approval of the Executive Board and those that arise in a section must have the approval of the section before they are submitted to the Executive Board. The manner of publication shall be at the discretion of the Executive Board.

A. C. DAHLBERG, President Elect.

Sutton moved and Trout seconded that a brief summary of the curriculum committee report be prepared for publication in the Journal, and that the detailed report be mimeographed for distribution.

Petersen moved and Gearhart seconded that the suggestion of printing news items in the Journal be referred to the Journal Management Committee. Meeting adjourned.

Thursday, June 24, 1943, 12:15 P.M.

Present: Davis, Trout, Becker, Gearhart, Petersen, Sutton, and Stoltz.

The minutes of the previous board meetings were read and upon motion duly seconded, they were approved.

W. E. Krauss, Chairman of the Committee on "Milk Production and the Feed Situation," appeared before the Board and presented his report. Petersen moved and Becker seconded that the report be accepted and recommended to the Association for adoption and immediate release.

Gearhart moved, and Petersen seconded that the History of Past Officers of our Association, Sections, and Divisions prepared by G. M. Trout be published in the Journal.

The Secretary read a letter from Past President George C. White.

Upon motion duly seconded the Journal Management Committee was authorized to arrange for the publication of a 5-Year Index from the 21st to the 25th volumes, inclusive.

Meeting adjourned.

AMERICAN DAIRY SCIENCE ASSOCIATION PRESENTED BORDEN AWARDS TO B. H. WEBB AND L. A. MOORE

University of Missouri

Columbia, Missouri, June 24, 1943

Mr. A. C. Ragsdale was toastmaster at the Annual Association Banquet and presented Mr. W. A. Wentworth of the Borden Company who gave a brief review of the Borden Award and introduced former recipients C. F. Huffman, W. E. Krauss, C. W. Turner, and W. E. Petersen from the Production Section of this Association, and L. S. Palmer and G. E. Holm who received their Borden Award through the American Chemical Society.

Mr. O. F. Hunziker, acting for Chairman Gregory of the Dairy Manufacturing Borden Award Committee, made the following statement:

"The purpose of the Borden Award to members of the Manufacturing Section of the American Dairy Science Association is to recognize meritorious scientific contributions or discovery pertaining to dairy manufacturing. The award consists of a gold medal and one thousand dollars which is offered by the Borden Company each year since 1936. The Borden Company has

requested that in the administration of this award, the American Dairy Science Association have complete jurisdiction over the rules governing the method of selecting the nominee and naming the recipient.

"The Award Committee, in selecting the nominee for this award, has taken into consideration the work done in the last five years, independence of thought in carrying out the research and the value of the research to the industry. The American Dairy Science members of the Dairy Manufacturing Borden Award Committee for this year are: P. F. Sharp, C. L. Roadhouse, and H. W. Gregory.

"Dr. Byron Horton Webb, the recipient of the Dairy Manufacturers Borden Award was the unanimous decision of the members of this committee. Dr. Webb received his B.S. degree in 1925 from the University of California, a M.S. degree from George Washington University in 1928 and a Ph.D. degree at Cornell University in 1931.

"Dr. Webb was employed as commercial ice cream manufacturer in 1925–26 and has been connected with the U. S. Department of Agriculture, Bureau of Dairying since 1926, with the exception of one year, when he held a Fellowship in Agriculture at Cornell University.

"Dr Webb's research has been concerned principally with improvements in the quality of evaporated milk, with the utilization of surplus dairy products in human foods and with the invention and development of new food products from skim milk and whey. He has published a number of articles and bulletins and has secured a number of patents relating to the handling of cream and concentrated milk. His work on evaporated milk has resulted in an understanding of the nature of color, body and stability differences in evaporated milk.

"It was the unanimous opinion of the Borden Award committee in Dairy Manufactures of the American Dairy Science Association that Dr. Byron Horton Webb be selected for the 1943 research award in Dairy Manufactures."

Dr. Webb came to the speakers' table and Mr. Wentworth of the Borden Company presented him a gold medal and a check for $1,000.

Mr. Ragsdale, toastmaster, then introduced Mr. O. E. Reed, Chairman of the Borden Award Committee for Production. Mr. Reed then made the following statement:

"Dr. Lane Ambrose Moore was born October 6, 1902, at Hillsboro, Ohio. He attended Oklahoma A. & M. College 1921–23, and received his B.S. degree at Iowa State College in 1926, his M.S. degree at Michigan State College in 1929, and his Ph.D. degree at the same place in 1939. He became associated with the Dairy Department of the Michigan State College in 1927. In 1941 Dr. Moore accepted a position as Associate Professor of Dairy Husbandry at the University of Maryland, where he is now located.

B. H. WEBB

L. A. MOORE

"Dr. Moore has been primarily interested in dairy cattle nutrition. He has made several outstanding contributions in this field. His greatest contribution has been the correlation of increased cerebrospinal fluid pressure with vitamin A deficiency. He was also the first investigator to use the ophthalmoscope in studying vitamin A deficiency in dairy cattle. Dr. Moore determined the vitamin A requirement of dairy calves based on cerebrospinal fluid pressure, ophthalmological observations and the vitamin A content of the blood plasma. He has also reported an accurate method for the determination of carotene in hay and silage and has studied the effect of maturity on the carotene of some of the common hays and pasture plants.

"Dr. Moore's study of the pathology of magnesium deficiency in calves was a meritorious scientific contribution.

"He worked out the rubber ring method of measuring the rate of food passage through the digestive tract of cattle. In connection with a long-time cottonseed meal-linseed meal experiment at Michigan State College, Dr. Moore found that cottonseed meal was not costive as had generally been assumed. His investigations also showed that bulk was not essential in the grain mixture of dairy cattle.

"The three members of the Production Award Committee have unanimously selected the recipient for the 1943 Borden Award."

Dr. Moore came to the speakers table and Mr. Wentworth presented him with a gold medal and a check for $1,000.

For over 58 years the biggest job of Patapar* Vegetable Parchment has been packaging and protecting foods. War needs resulted in a new appreciation of what this remarkable paper can do, and today Patapar has many important war assignments. Most of them cannot be talked about, but here are a few examples:

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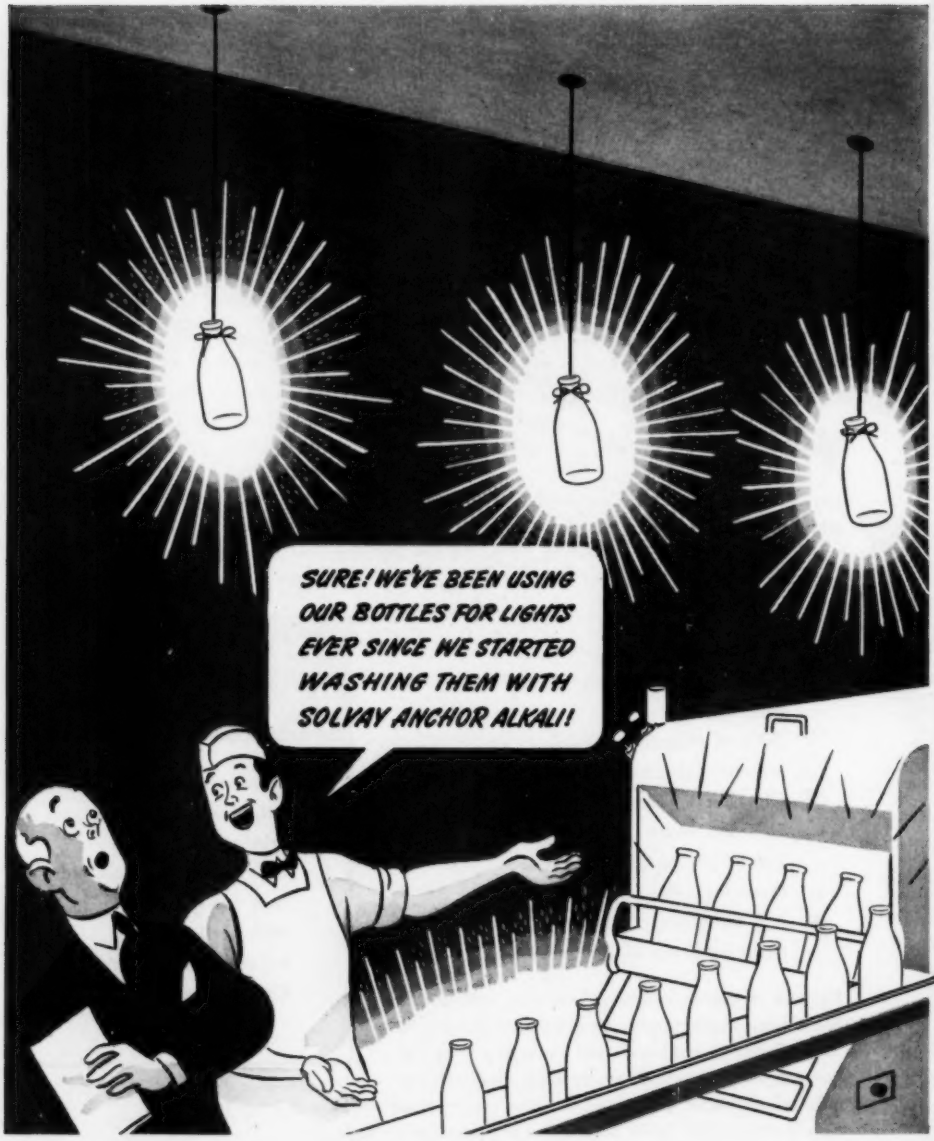

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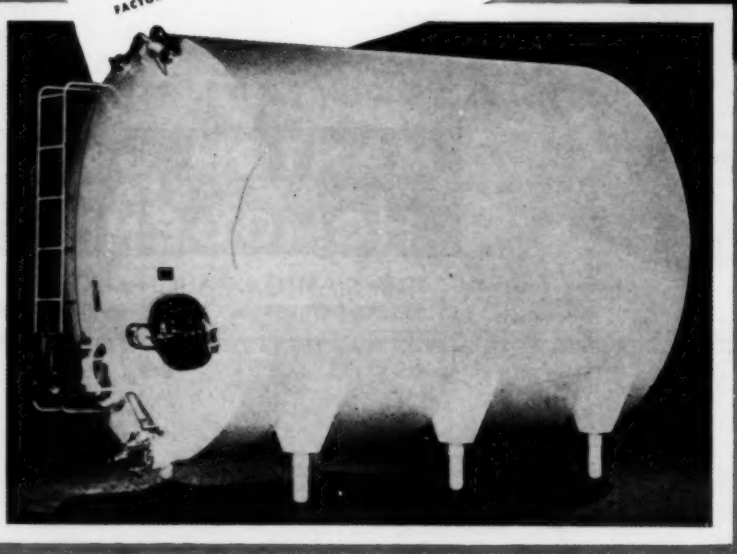

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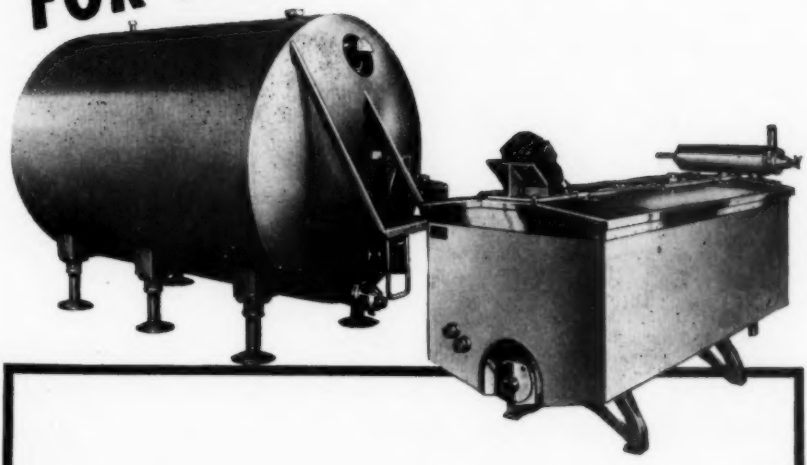

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Bacto-Tryptone Glucose Extract Agar

is recommended for use in determining the total bacterial plate count of milk in accordance with the procedures of "Standard Methods for the Examination of Dairy Products" of the American Public Health Association.

Upon plates of medium prepared from Bacto-Tryptone Glucose Extract Agar colonies of the bacteria occurring in milk are larger and more representative than those on media previously used for milk counts.

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is recommended for use in determining the bacterial plate count of Certified Milk. The formula for this medium corresponds with that suggested in "Methods and Standards of Certified Milk" of the American Association of Medical Milk Commissions.

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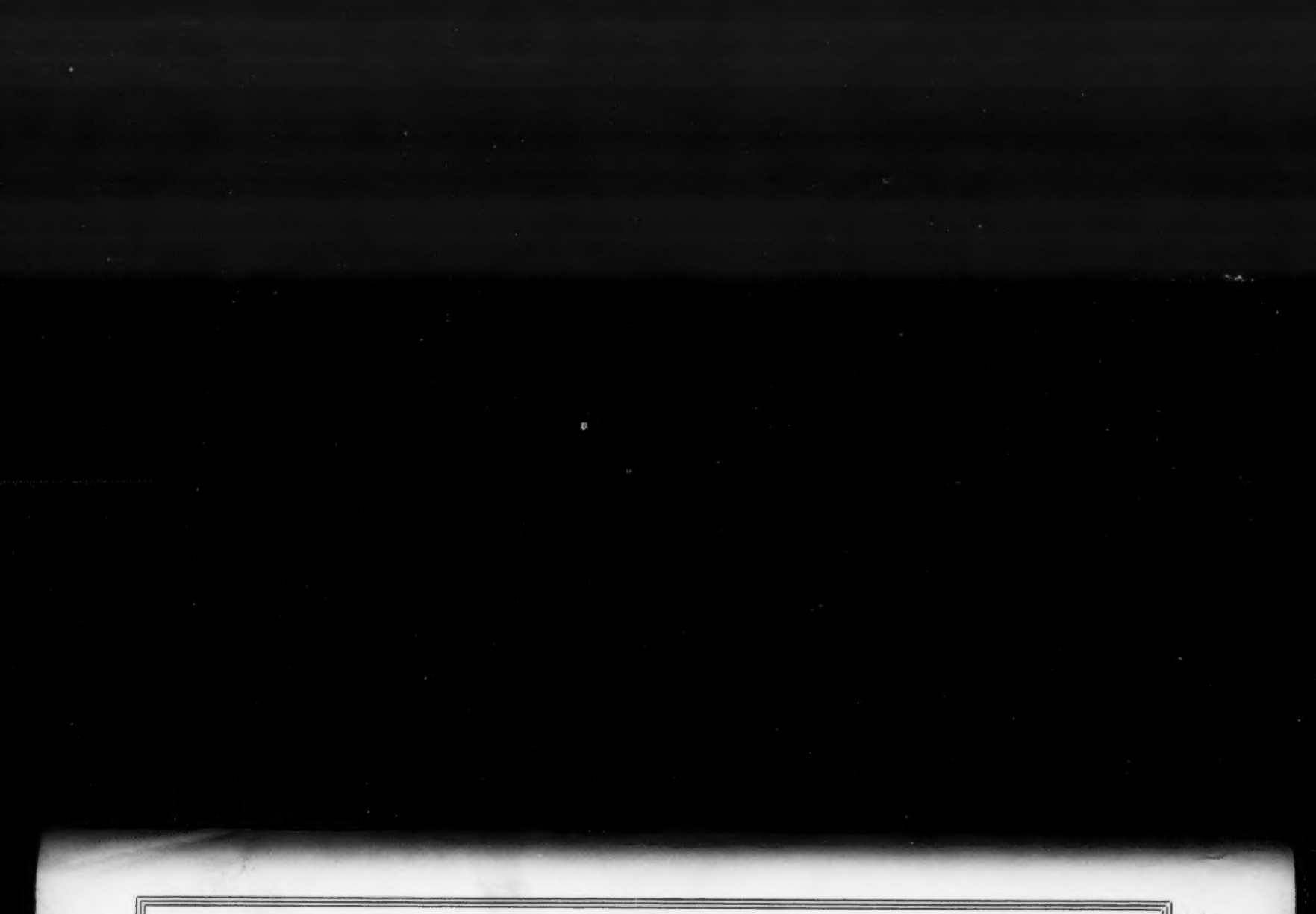
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